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"To the solid ground
Of nature trusts the Mind that builds for aye."—WORDSWORTH.

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NATURE

SATURDAY
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INDUSTRIAL ADMINISTRATION AND ECONOMIC POLICY

FAR more effectively than the Limitation of Supplies Orders or the policy of concentration of production already announced by the President of the Board of Trade, the rationing of clothing in Great Britain has brought home to every member of the community the importance of utilizing to the maximum advantage all our resources of moneys, materials and man- or woman-power. The contribution and co-operation of the individual citizen are essential, but our war effort may fail of its full effect if they are not directed and utilized to the utmost by wise administration and skilful management, whether on the part of Departments of State or in industry. The significance of scientific management and sound administration can scarcely be overstressed. They affect most powerfully the morale of the general population, which in total war is of as much importance as maintaining morale in the fighting services.

There are, unfortunately, many signs that this is far from being generally realized, or at any rate invariably served, by management or administration, as recent reports of the Select Committee on National Expenditure indicate. Its recommendation that day-time manning strengths in the civil defence services should be reduced to the minimum consistent with safety was prompted largely by the importance of minimizing the detrimental effect on morale and efficiency of an unnecessarily large amount of standing-by and waiting. The severity of its censure on the Ministry of Health for failure to supply information which would permit a judgment as to whether nursing staffs in the emergency hospital service are excessive is to be attributed as much to the desire to avoid waste and damage to morale of staff kept standing by unnecessarily, while similar staff elsewhere is overstrained, as to the ineptitude and incompetent administration thus revealed.

Other disclosures of the detrimental effect of inefficient administration on economy are contained in the twelfth and fifteenth reports of the Committee. In the former, sharp comment is made on the deterrent effect, as regards suggestions for increased economy and efficiency, of the cumbrous machinery through which these suggestions have to pass before reaching a level at which decisive action can be taken. Sensible suggestions, moreover, have been turned down as a matter of routine, apparently before reaching an officer who was sufficiently informed to appreciate them. In the matter of complaints, this position leads to the

more vigorous or influential complainants taking undesirable short cuts to overcome their personal difficulties, and it does not appear that the administration has been sufficiently wise to appreciate the way in which this state of affairs merely increases the difficulties of others, engenders friction and reduces general efficiency.

Other indictments of administrative neglect of elementary principles of scientific management are seen in the fact that valuable information can often only be acquired by direct contact with those who have to give practical effect to decisions and are usually working away from headquarters, and the Committee comments that, however effective may be the various means of collecting information, this work will be wasted unless its results are rapidly brought to the notice of those who have power to decide what modifications of practice and policy may be immediately required.

The Select Committee points out that apart from the failure of information and criticism to percolate from those actually carrying out the work to those who are directing and controlling it at the centre, highly placed witnesses have made statements which suggest either that they are unaware of some of the relevant facts and considerations, or that they have not fully appreciated their practical significance. It is sometimes difficult to escape the impression that they work in an atmosphere which is too strongly buffered from outside impacts. Moreover, the Committee stresses the great importance that the facts which it has readily been able to collect, but which, under war conditions, it is unable to support by full publication of the evidence taken, should have been collected, sifted and studied by responsible officers in the departments. Only in this way can recommendations for reducing waste by increasing efficiency of management be judged in their correct setting.

Whereas the disclosures in the fifteenth report are primarily those of failures of human nature, the need for effective administration is no less clearly indicated. The suggestion that idle labour was becoming a permanent and undesirable feature in the aircraft industry generally is disturbing, and all the more in the evidence of management so inept that it failed to keep the essential records which the Select Committee has now recommended should be enforced. Similarly, the recommendations that the Ministry of Labour should endeavour by publicity to give women a better idea of the kind of factory work for which they are needed, that Sunday labour should be discontinued except for the maintenance and repair of plant and other essential purposes, and that the Ministry of Aircraft Production should do everything in its power to ensure that factories working for it, either commercially or on a management fee basis, observe district federation wage-rates and keep their bonus percentages in line with those of their neighbours, involve essentially reflections on the foresight, imagination and competence of the administrations concerned.

It would be unfair to suggest that the question of absenteeism, which the Select Committee finds so disturbing, is one for management alone. With so much evidence of inefficient, if not incompetent management, however, it is difficult to believe that improvement in this respect and the maintenance of a more scientific standard would not go far to reduce avoidable absenteeism to a figure when it should easily be possible to deal with recalcitrant elements in personnel. In any event, we cannot afford in war-time to tolerate ineptitude and incompetence in management. The Select Committee's reports alone afford sufficient evidence of the waste and difficulties which flow from this source.

Unquestionably these reports indicate that civil administration in Great Britain is far from attaining the standard that the country has a right to expect. The restrained criticism is a severer indictment of civil service efficiency than such violent attacks as those of Lord Percy, and it would be reassuring to learn what action has been taken upon recommendations so authoritatively prepared and objectively stated. Nor is the indictment of industrial management any less penetrating, and it is scarcely reassuring to find, in view of the shortcomings of industrial management simultaneously exposed, that leading positions in the Ministry of Supply, the Ministry of Aircraft Production, the Ministry of Food and the ministries concerned with economic reconstruction have been entrusted to representatives of industrial organizations, rather than to individuals on their outstanding ability.

It is for this reason that Mr. Hugh Quigley's pamphlet in "The Democratic Order" series* is timely. He subjects the whole structure and policy of industry in relation to efficient administration and control to analysis from the point of view of serving the needs of the community—the *raison d'être* of industry in the ultimate analysis. Funda-

* End Monopoly Exploitation: a Policy for Industry. By Hugh Quigley. (The Democratic Order, No. 15.) Pp. 63. (London: Kegan Paul and Co., Ltd., 1941.) 1s. net.

mentally he raises the question, not so much of industrial policy, as of the machinery of government and its adequacy under present and post-war conditions.

Mr. Quigley makes his first important point in suggesting that the present industrial order should be replaced by one in which industry is subordinate to the State, in so far as the State seeks to advance the public welfare, and in which industry does not at any point dominate the public, either through its organizations or through its methods of representation. This involves a sense of public responsibility as well as of efficient management which have not been approached even by the new types of public corporation. As Mr. Quigley points out, where such authorities as the British Broadcasting Corporation, the Central Electricity Board or the London Passenger Transport Board have failed, has been in their approach to the larger problems of public service which give the justification for their technical privileges. We can scarcely expect more of the executives of the industries bordering on coal-mining, building, iron and steel, chemicals, shipbuilding, electrical engineering, agricultural, or the distribution of foodstuffs, especially in the light of the evidence of the Select Committee on National Expenditure reports.

This judgment, however, narrows the problem to one not so much of executive ability or technical efficiency as to one of managerial responsibility and executive vision, and Mr. Quigley points out first that the character of new State enterprises such as the public utility companies tends to reflect the character of the national executive, and that accordingly some kind of division must be made between purely technical management, which is usually efficient, and the wider aspects of national policy which are expressed in such management. The nature and limitations of any organization created to obtain better results from the point of view of the public welfare are a matter for investigation and, for all his insistence on the necessity for some such development, Mr. Quigley is unconvinced that far-reaching nationalization is the remedy.

The great difficulty is that of higher control; this has never been adequately considered by those who advocate the most thorough-going socialization. Moreover, attempts to co-ordinate economic policy are faced with the absence of any conception of what the tactics of higher control in economic matters should be. This is the real reason for the confusion existing, for example, in agriculture and in the marketing and distribution of food.

If we accept as basic the principle that no public utility or industry should be allowed to have a vested interest other than that involved in efficient production, a considerable amount of well-defined and well-supported technical, economic and social research will be required before we can evolve the technique and policy for the higher impartial controlling authority, which must possess not merely advisory functions, but also full executive powers. It involves, indeed, reconsideration of the whole machinery of government. It will be recalled that the Haldane Committee, which clearly envisaged this problem, while firmly rejecting a proposal to concentrate the administration or supervision of private enterprise in production under the same department concerned with the administration of nationalized services, contemplated some development of the Board of Trade in this field of production, but laid its main stress on the need for further provision in the sphere of civil government for the continuous acquisition of knowledge and the prosecution of research to furnish a proper basis for policy.

Mr. Quigley takes no pessimistic view of the capacity of democratic government to evolve the appropriate instruments to prevent in future the development of industry without regard to the needs of the community. Protection against exploitation, increasingly high standards of public service on the part of industries and public utilities and the right to call to account, as those in military or naval command are called to account, those in charge of such industries and public utilities if their administration fails to display courage, vision or disinterested statesmanship—these are no Utopian ideals. Despite all the evidence of inefficiency or negligence or disregard of public interest, there is no sign that the community is unable to throw up, either in the service of the State or of industry, those possessing administrative ability, high ideals, wide vision and unassailable integrity. The fields of thought and inquiry opened up by Mr. Quigley and by the Select Committee's reports go far beyond the structure of industry and organization of government: they embrace the whole character of our educational system and its capacity to throw up leaders. That these suggestions should be voiced, however, attests the vitality of democracy and its capacity of adjustment and development to meet the changing needs of a dynamic society.

SCIENCE AND THE STRUCTURE OF SOCIETY

The Social Relations of Science
By J. G. Crowther. Pp. xxxii+665. (London: Macmillan and Co., Ltd., 1941.) 16s. net.

WHEN, eighty years ago, H. T. Buckle wrote his "History of Civilization in England", his main thesis was that the course of human progress could be traced in the growth of scientific truth. He applied scientific principles to the study of history, but measured progress too much by materialistic achievements for his analysis of causes to be accepted by historians as complete. Mr. J. G. Crowther takes a truer and broader view of the social and intellectual influences of natural knowledge, and is not so much concerned with maintaining a proposition as in presenting a picture of creative scientific thought and action. He has long been esteemed as a clear interpreter of scientific developments to general readers, through his articles in the newspaper press and other literary works; and he realizes fully the relations between these advances and the structure of society.

The theme of Mr. Crowther's book is essentially that of Francis Bacon's phrase: "All knowledge should be referred to use and action." This maxim is, however, not fully representative of Bacon's regard for the pursuit of knowledge as an end in itself, and the expression of a natural desire to discover the truth by experiment. His words, "Itaque ipsissimae res sunt (in hoc genere) veritas et utilitas", in Aphorism cxxiv of the "Novum Organum", have been variously rendered, but their meaning is "Truth and utility are in this kind the very things we seek for".

Whether or no Bacon held more liberal views of the relation between knowledge and practice than are expressed in the phrase which is the keynote of Mr. Crowther's book is, however, unimportant. It is contrary to the spirit of modern science to be bound by the words of any master; and the story of progressive knowledge and changing social conditions told impressively in the book implies nothing of this kind. It is a concise survey, under eighty-three headings, of the repercussions of science and society from the time when man became a tool-making animal to the present day. Man had to acquire knowledge of the properties of things around him in order to supply his daily needs. His primary purpose was "use and action", but this was often diverted into new directions by innate curiosity and the desire to control mysterious characteristics of natural objects and events. As a craftsman, he was concerned with applications of science and manual skill rather than with the philosophy of causes and consequences, which belonged to the fields of magic and religion.

Early man learned by practice how to increase food supply by the cultivation of plants and the domestication of animals, and by the invention of the bow for hunting and protection. He began to learn how to be master of Nature instead of her servant. The scope of interest and activity expanded from the family to the village and then to urban cities in the great river valleys of the Nile, Euphrates and Indus, with a consequent growth of specialization of function and increase of social authority. With this expansion were associated the concentration of wealth and distinctions of social status between craftsmen of various types and other members of the community. The introduction of organized warfare to extend possessions brought captives as well as land and booty. The captives became slaves; and the manual work involved in the crafts of metal-working, weaving, pottery and like creative activities lost its social dignity.

"The notable decline of invention", says Mr. Crowther, "after the stabilization of city life in Babylonia and Egypt occurs in parallel with the increase of slavery, the loss of status of craftsmen, and the concentration of wealth." He traces this decline through the classical period of Greece and Rome, when manual workers were of the slave class and most of the inventions were made by them. Concentration by the Romans upon law and administration led to the distinction "between the creative and organizing factors in civilization, which still persists, and is one of the causes of modern social disorder". Plato taught that pure science was a subject for gentlemen, and practical applications of knowledge were for people of a lower standard. He used the same Greek word in referring to the manual operations in surgery as in carpentry, with the result that the influence of his teaching led surgery to become the profession of barbers. Though Galen made his own dissections, his successors relegated them to slaves and servants because of the low esteem in which manual work of any kind was held.

It was a village carpenter, Jesus of Nazareth, who by his ethical teaching and noble life established a social philosophy in which the manual worker was again given his rightful place in society. "The Christian doctrine of human equality has had profound influence on the restitution of the dignity of human labour and this indirectly on

experimental science." It cannot be said that Christian civilization to-day, or at any time, has seen the fulfilment of the teaching of its Founder, but it represents a vast advance upon the conditions of life and service which prevailed in Græco-Roman times. Its defects are due not to faults in the humane principles of its message, but to the neglect to put them into practice. Lust for power and property, in individuals and in communities, is similarly responsible for the perversion of the gifts of science. Scientific workers are, however, beginning to realize that they have a social mission to undertake, as well as the right to pursue natural knowledge as an intellectual activity or with practical purpose in mind.

Mr. Crowther's suggestions as to the organization of scientific work on the basis of Bacon's maxim of "use and action" will not be readily accepted by those who believe in the pursuit of knowledge for its own sake, without regard for its proximate or ultimate service to the community, but the deplorable social and international conditions in the world to-day demand that heed should be given to them. His book is a thoughtful and thought-provoking sketch of the influence of science upon society and of society upon science. The apostle whom he follows is Bacon, whose insight into the social relations of science led to the foundation of the Royal Society. The early interests of the Society were in investigations planned to benefit mankind, but after a time they became specialized and professionalized, and the social contacts were correspondingly diminished. Mr. Crowther sees in the scientific movement in recent years, represented in addresses of presidents of the Royal Society and the British Association, and by the formation of the Association's Division for Social and International Relations of Science, signs of a revival of the Baconian principles of service. His interesting and stimulating book should help to dispose of the remark that "We learn from history, that we do not learn from history".

R. A. GREGORY.

BIOLOGICAL OXIDATIONS

Mechanisms of Biological Oxidations
By David E. Green. (Cambridge Biological Studies.) Pp. vi+182. (Cambridge: At the University Press, 1940.) 12*s*. 6*d*. net.

THE study of the mechanisms of biological oxidations has made such rapid strides during the last fifteen years that adequate reviews of the progress made are most welcome. Dr. Green's book gives a readable and concise account of many of the major advances which have been made recently in the field of biological oxidations.

The enzymes, important in oxidative systems, which Dr. Green describes are prefaced by a short introduction to the general properties of enzyme systems. The introduction resolves itself into a survey of the properties of amino-acid oxidase, an enzyme found in kidney extracts. This enzyme is chosen to familiarize the reader with the properties of oxidative enzymes, on the grounds that its general properties " may be assumed to parallel those of other oxidative enzymes". It is, however, unfortunate that Dr. Green should have chosen this example as a typical oxidative enzyme, for the amino-acid oxidase of tissue extracts is confined in its activities to the oxidation of the unnatural amino acids (that is, of the *d*-configuration). It must, therefore, be regarded as distinct from most other oxidative enzymes which attack naturally occurring substances. The enzyme has other properties not shared by most other oxidative enzymes; for example, it is able to attack a large number of substances having a special configuration, a property shared by hydrolytic enzymes and certain oxidative enzymes, but not shown by a large number of oxidative enzymes the most striking property of which is their specificity of attack; again it forms hydrogen peroxide as a result of its oxidative activity, a property shown by enzymes such as amine, choline and xanthine oxidases but not by the majority of dehydrogenases.

Possibly the property which Dr. Green is most anxious to demonstrate in the enzyme, the properties of which are assumed to parallel those of other oxidative enzymes, is the fact that the enzyme can be resolved reversibly into two constituents, a protein and a yellow compound neither of which is catalytically active but together form the active enzyme. The yellow compound, shown to be a flavin adenine nucleotide, has been termed a prosthetic group of the amino-acid oxidase. Many oxidative enzymes are now known to be capable of dissociation into a protein and a substance the chemical structure of which is known. Neither the protein nor the dissociated substance—the 'prosthetic group'—has catalytic properties; the combination of the two apparently constitutes the enzyme. This interesting fact,

made clear by the work of Warburg and of Euler, forms the main theme of Dr. Green's book.

Dr. Green considers that the oxidative enzymes are best classified by reference to the chemical nature of their prosthetic groups, and is evidently more concerned with such a classification than with any attempt to describe the enzymes with reference to their share—quantitatively as well as qualitatively—in the oxidative metabolism of the living cell.

The enzymes are named, following Warburg's nomenclature in describing enzymes, according to the chemical nature of the prosthetic group. They are grouped into the following classes :

1. *The iron porphyrin protein enzymes*—so called because the prosthetic group is iron porphyrin. These include catalase and peroxidase.

2. *The pyridine protein enzymes.* Here the prosthetic group is a compound of nicotinamide, ribose, phosphoric acid and adenine. The enzymes include a large number of the well-known dehydrogenases.

3. *The flavoprotein enzymes.* The prosthetic group is a compound of flavin, ribose and phosphoric acid. Adenine may also enter into the composition of the prosthetic group. These enzymes are responsible for the activation of *d*-amino acids, dihydrocozymase and probably of xanthine, hypoxanthine and certain aldehydes.

4. *Copper protein enzymes*—so called because copper appears to be indispensable for the activity of the enzymes and is united with the special proteins involved. Such enzymes are polyphenol and monophenol oxidases, laccase and ascorbic acid oxidase.

In all cases the highly specific structures of the enzymes are the proteins, one prosthetic group being capable of combining with a number of different proteins and forming different catalytic systems.

The adoption of the Warburg nomenclature is still clearly a matter for argument. It facilitates at present a certain clarity of exposition but its implications are such as not to be accepted by all workers in the subject.

Further chapters in Dr. Green's book deal with what are termed thiamino proteins, that is, enzymes such as carboxylase and pyruvic oxidase which require the presence of thiamine (or vitamin B_1) pyrophosphate for their activities, and with enzymes which Dr. Green finds difficulty in classifying but are grouped together as they all seem to reduce cytochrome in presence of their respective substrates without the necessity of an intermediate carrier. There is finally a block of enzymes which apparently defies attempts at classification and these are put by Dr. Green in a chapter entitled "Unclassified Oxidative Enzymes".

It is important to point out that this account of enzymic oxidations is limited largely to one aspect of oxidative phenomena, namely to those reactions taking place in tissue extracts or in isolated enzyme systems. The result of this limitation of treatment is that in a book consisting of 178 pages of text, 163 pages are devoted to descriptions of the properties, and the modes of preparation, of a variety of isolated oxidative enzyme systems, whilst the remaining pages are concerned with brief comments on oxidations as they are known to occur in intact animal tissues. Dr. Green remarks (p. 164) "there is a tendency for those who are engaged in the reconstruction of cellular oxidations to forget that the countless chemical permutations and combinations, of which the isolated components of oxidative systems are capable, cannot be assigned physiological significance until some counterpart of these events is shown to take place in the intact cell or organism. It is becoming increasingly clear that the study of enzyme systems cannot be divorced from the study of the intact cell and *vice versa.*" It is a pity, in view of such a commendable statement, that Dr. Green has not paid at least as much attention to the experimental facts bearing upon oxidations as they occur in intact cells and tissues as he has to the phenomena observed in isolated enzyme systems.

In a book of this nature, where most prominence is given to the enzymes the prosthetic groups of which have been the subject of much investigation, it is natural that there should be many omissions. It is, however, surprising that so little mention is made of the work on tyrosinase and melanin formation, that no reference is made to the mutual oxidations and reductions undergone by amino acids in presence of strictly anaerobic micro-organisms—reactions which are vital for the proliferation of these cells—that in a discussion devoted to glycolysis and fermentation no mention is made of the enzyme hexokinase, which transfers phosphate from adenylpyrophosphate to glucose or fructose and so on.

There are certain errors in the text requiring alteration. Thus on p. 25, line 22, "10 g." should read "50 g." and on page 113 there is a curve which may lead one to suppose that the copper content of polyphenol oxidase may reach 300 per cent!

Dr. Green's book must be considered of real value to the teacher and to the more advanced student of biochemistry, so long as the limitations which have been expressed above are recognized.

The book is well printed and produced. It is a pity, however, that its cover should be spoiled by some obvious misprints.

J. H. QUASTEL.

NORTH AMERICAN HARDY TREES AND SHRUBS

Manual of Cultivated Trees and Shrubs Hardy in North America

Exclusive of the Subtropical and Warmer Temperate Regions. By Prof. Alfred Rehder. Second edition, revised and enlarged. Pp. xxx+996. (New York: The Macmillan Company, 1940.) 42*s.* net.

THE first edition of this notable work appeared in 1927 and set a new standard for its kind. A nineteen-page supplement of corrections and emendations appeared in 1935. The original issue is now exhausted, and as in the interval new species and hybrids have been named and introduced and the cultivation of others extended, the new edition now includes more than 2,500 species fully described, with 2,685 varieties, and 1,940 species and hybrids briefly mentioned.

The small half-page map illustrating zones of hardiness in the United States has been replaced by one partly coloured facing the title-page. In the process of revision certain alterations have been made. Monocotyledons have been placed at the end instead of immediately preceding the Dicotyledons, and the bamboos subdivided into ten instead of three genera. Original authors are cited in parenthesis (for example, *Petrophytum cæspitosum* (Nutt.) Rydb.), a practice which may assist in tracing descriptions or illustrations. Varietal and other subdivisional epithets now immediately follow the specific name, the category proposed by the first author of a trinomial being placed immediately after it (for example, *Ribes alpestre giganteum* Jancz., var.). This is to avoid making numerous new combinations, since the author does not always agree with the conclusions of other botanists.

Sequoiadendron has been separated from Sequoia, Halimium from Helianthemum, and Weigela from Diervilla, all with good reason. There is a considerable increase (twenty-four species) in Rhododendron, reflecting the spread of this genus into American gardens. Some additions noticed are *Carmichælia australis*, the hybrid *Caryopteris clandonensis*, the monotypic genus Kalmiopsis, the bi-generic hybrids Gaulthettya and Pyracomeles, etc.

It is Prof. Rehder's intention, however, to publish a bibliographical supplement which will include not only exact citations of their source for all names and important synonyms mentioned in the "Manual", including both varieties and forms which are often difficult to trace, but also, in the case of trinomials, the category considered to be botanically correct.

In a work of this magnitude and detail typographical and other errors are almost unavoidable, although of the former many have been corrected since the earlier edition. Muhlenbeckia instead of Muehlenbeckia in the index, on p. 579 Parsonii for Parsonsii, and on p. 887 *Bambusa metake* for Metake are examples.

The spelling of certain specific names is apparently not always in accordance with the Rules. Instances are *Pyrus kumaonensis*, *Rhamnus Erythroxylon*, *Rosa Lheritierana* and *Spiræa Billiardii*.

A few authors are incorrectly cited, for example, *Prunus tangutica* Batal., for Koehne, *Lavandula latifolia* Vill., not Linn., and *Daphne hybrida* Sweet, not Lindl. Some recent changes in nomenclature have not been taken up, such as *Magnolia heptapeta* (Buc'hoz) Dandy, *Betula platyphylla* Sukatchev for *B. mandshurica* (Reg.) Nakai, and *Ulex minor* Roth for *U. nanus* Forst. The dates of introduction to cultivation are not always accurate; for example, *Forsythia Giraldiana* was introduced by Farrer in 1914, *Euonymus oresbius* and *Berberis sublevis* by Forrest about 1919, whilst Orphanidesia has been growing in England for some years, although only lately figured. The flowers of *Magnolia Dawsoniana* are now known and have been described. On p. 562 the derivation of Glossopetalon is supplied instead of *Forsellesia*, and *Rubus japonicus* Linn. is cited on p. 406 as a synonym of *Kerria japonica* (Linn.) DC., instead of the much more common *Corchorus japonicus* Thunb.

For the most part, however, these are comparatively small points which can be corrected as they are discovered. A more definite want, particularly to British users of the book, is the omission of a number of genera and species hardy in many parts of these islands and almost certainly equally hardy in Zone VII of Prof. Rehder's map. Azara, Desfontainea, Fabiana, Corokia and Mutisia come to mind, while *Cytisus Battandieri*, *Ceanothus rigidus*, *Telopea truncata* and *Viburnum Tinus* should certainly be included.

Apart from these criticisms it is scarcely possible to over-estimate the value of this comprehensive and laborious work to those whose work or hobby brings them into close contact with trees or shrubs. Nurserymen, botanists, foresters and amateur gardeners can all learn from it, and if it was more widely utilized there would be a great improvement in the general nomenclature of woody plants in cultivation. The new "Manual" is a most welcome addition to the bookshelf, and will become the same guide and authority which its predecessor has been.

B. O. Mulligan.

TSWETT'S ADSORPTION ANALYSIS

Principles and Practice of Chromatography
By Prof. L. Zechmeister and Dr. L. Cholnoky. Translated from the second and enlarged German edition by A. L. Bacharach and F. A. Robinson. Pp. xviii+362. (London: Chapman and Hall, Ltd., 1941). 25s. net.

THE removal of coloured impurities from solutions by shaking with charcoal is the most familiar application of adsorption, and chemists have shown enterprise in improving the adsorbent by 'activation' and in finding new ways of using the material. In applying adsorption to analytical problems, however, it was left to a botanist, Prof. M. Tswett, to display initiative and imagination and present chemists with a device of great value. He allowed coloured solutions to percolate through a compressed column of adsorbent, and by using finely divided calcium carbonate instead of charcoal, he was able to follow visually the track of the pigments. Different coloured substances travelled down the column at different speeds and the resulting separation into coloured zones could be enhanced by 'developing the chromatogram', that is, by allowing sufficient of the pure solvent to pass down the column after the solution had all come into contact with the adsorbent.

The possibilities of the new method were recognized very slowly. Tswett's monograph entitled "Chromophylls in the Plant and Animal Worlds" (Warsaw, 1910) was published in Russian, but the neglect of his work was not really due to inaccessibility because it was described in several papers in well-known German journals during the period 1906–12. Even the encomiums of Willstätter and Stoll in 1910 and 1912 made little impression, and it was not until 1931, when Kuhn and his colleagues succeeded in isolating pure α- and β-carotene by the use of the method, that Tswett's procedure came into its own. Nor can it be said that the potentialities of the method were unforeseen, for Tswett had himself predicted on good evidence, so early as 1910, that 'carotene' could be separated in this way.

The neglect which is often the fate of a new device or technique arises more often than not from what is practicable in research rather than from dullness of mind. Three advances contributed to the new interest in Tswett's work; the first was Pregl's in the technique of micro-analysis, the second the discovery that carotene was somehow connected with vitamin A, and the third was that the determination of the structure of carotene began to look feasible, Zechmeister having made a promising start. From 1931 onwards the successes of adsorption analysis have been so numerous that the method has become indispensable.

A monograph on the subject was produced a few years later and proved to be a model of its kind, and the need for an English translation was at once recognized by Mr. Bacharach in reviewing the first edition in NATURE (July 10, 1937). A second edition was soon called for (NATURE, April 8, 1939), and Mr. Bacharach has added to his many services to chemistry in producing this careful translation. If the English sometimes lacks the verve of the translators' own writings, it is meticulously accurate, apart from the title.

Chromatography, according to the dictionary, is the *description of colours*, and the word was used in 1731 and 1835 in the titles of treatises on colours and pigments. The title of Zechmeister and Cholnoky's volume, namely "The Chromatographic Adsorption Method", is perhaps a little cumbrous in English.

The book contains a full account of the many technical developments which have resulted from the wider application of the method and of the achievements to be credited to them. Each topic is dealt with in its proper setting, so that many fields of research are reviewed in an interesting way which adds greatly to the value of the work.

To carry out with one's hands a complete and flawless chromatographic separation is a difficult but satisfying achievement, and simple exercises can be devised which give students enjoyment and training in craftsmanship. Many perfectly developed chromatograms of leaf pigments were produced under the direction of Baly and Heilbron in 1922–23, and to-day the photographs recording those experiments tell their own story. A vast literature of research, however, lies in between, and it seems not unlikely that Tswett's method came into general use only when the time was ripe.

Zechmeister and Cholnoky in the preface to the second edition explain that they had intended to include a biography of Tswett, but they add that "trustworthy information about the active life of this pioneer has, however, not so far been available to us". It is to be hoped that circumstances will permit those who knew Tswett to provide a record of his life and work, for the debt we owe to him is great and increasing. R. A. MORTON.

Elementary Physics

For Medical, First Year University Science Students and General Use in Schools.

By Prof. G. Stead. Sixth edition. Pp. xiv+562. (London: J. and A. Churchill, Ltd., 1940.) 12*s*. 6*d*.

PROF. STEAD'S book is primarily intended for the use of medical students and first-year university students, though the author expresses the hope that it will be found useful for School Certificate and Higher School Certificate candidates. In a single book covering such a wide field, it is not possible to treat the various topics as fully as perhaps one would wish and it is intended that the book should be used in connexion with a course of lectures with practical demonstrations. So far as Higher School Certificate work is concerned, this plan would be necessary. In the main, the book is up to date; it seems a pity, however, that the more convincing method of using actual beams of light instead of pins in verifying laws in connexion with mirrors and lenses is not advocated. Also in a modern text-book surely less space should be devoted to the 'shadow' and 'grease spot' photometers, and more attention paid to modern instruments to bring the subject into line with modern practice.

The book is excellent in its way; the diagrams are good and plentiful, and so far as space will allow the facts are presented clearly. It is, however, definitely a book for specific examination purposes, and apart from the stress made on medical applications, there is little attempt to correlate physical principles with everyday life; probably for a single text-book too much has been attempted.

First Course in Theory of Numbers

By Prof. Harry N. Wright. Pp. vii +108. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 12*s*. net.

WHAT is the minimum knowledge of the theory of numbers that every mathematician should have? The question must be elaborated. "Should", because ignorance is likely to detract from his efficiency whatever his own field may be? Then he needs very little: the Euclidean algorithm and its direct consequence in the existence of identities of the form $ax-by=1$; nothing at all about continued fractions, if the current fashion is a safe guide. "Should", in order to discover whether the subject makes any appeal to him? Then add the elements of linear congruence, and a few classical theorems such as Fermat's. "Should", if he cares about being well-read in pure mathematics generally? Then include simple continued fractions and the law of quadratic reciprocity.

Prof. Wright's book is a college course, appropriate in scope to the last class of reader, and with a satisfying unity, but rather expensive regarded as a substitute for four or five chapters of a text-book on algebra. The author has succeeded in infusing his enjoyment of the subject into a sound exposition. Confusion on the eastern side of the Atlantic is almost inevitable: this bookwright is not Prof. Hardy's collaborator in the same domain. E. H. N.

Calculations of Quantitative Analysis

By Prof. Carl J. Engelder. Pp. viii+174. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 12*s*. net.

THIS book, which is up to the English Intermediate Degree standard, gives a straightforward account of the theory underlying the calculations in quantitative analysis. The text is illustrated by a large number of worked-out problems, and each of the fifteen chapters concludes with original calculations for the student to work out for himself. Answers are only given to the odd-numbered problems, since these are intended for home-work, but those to the even-numbered problems can be obtained on application to the publisher.

The book is divided into four parts. The first part is devoted to general considerations such as the use of logarithms and the methods of designating the strength of solutions. The calculations in volumetric work are considered in the second part, and this includes the calculation of values in acid-base titrations. Part 3 is devoted to gravimetric analysis and includes a chapter on the solubility product principle. The fourth part deals briefly with the application of analytical data, as for example, the calculation of atomic weights.

The subject-matter in these four parts is generally sound and up to date, though the statement (p. 58) that salts of the sodium chloride type are ionized 80 per cent or more in 0·1 *N* solutions is not in keeping with modern theory. Similarly, it is confusing to find a calculation (p. 129) on the hydrogen ion concentration of a mixture of 0·5 *M* acetic acid and 0·3 *M* sodium acetate in which an allowance is made for the 78 per cent ionization of the salt.

At the end of the book, in addition to an index and logarithm tables, there is a large number of tables of physical properties, such as the specific gravities of acids and alkalis and the solubility of salts, which should prove very useful in the laboratory. A. C. C.

Organic Chemistry

By Dr. F. Sherwood Taylor. Third edition. Pp. xi+588. (London: William Heinemann, Ltd., 1940.) 10*s*. 6*d*.

DR. TAYLOR has established a reputation as a writer both of text-books and more popular works on science, and he is thus able to put a little more feeling into his descriptive organic chemistry than is customary—some of the compounds seem to have life and uses and to be something more than colourless crystalline compounds having the formulæ indicated. It is a task to get all organic chemistry into 500 pages; the same number of specialized monographs would scarcely do it. Yet something has to be provided to enable the student to beat the examiner. The book has a biological bias as is to-day proper: it contains the essential significant facts about the commoner organic compounds, the presentation is clear and we have no hesitation in recommending it as in many ways superior to its competitors.

E. F. A.

THE ORIGIN OF MAN

By Dr. R. Broom, F.R.S.
Transvaal Museum, Pretoria

WHEN, in 1924, Dart of Johannesburg discovered a type of fossil anthropoid more man-like than the chimpanzee or gorilla, a new chapter was opened in the early history of man. Dart named his fossil form *Australopithecus africanus*, and he regarded it as somewhat intermediate between the living anthropoids and man, and probably near to the anthropoid from which man arose. The first account of the discovery was given in NATURE of February 7, 1925.

The skull which Dart had discovered was unfortunately that of a young child-ape of about five years, and a few of the rather striking human resemblances were no doubt due to the immaturity of the specimen; and the majority of men of science were not inclined to accept Dart's opinion. They regarded the animal as closely allied to the chimpanzee, though with a few human characteristics apparently acquired by a parallel development. One authority considered that the skull is only "the distorted skull of a chimpanzee".

A few of us have consistently maintained since 1925 that Australopithecus is not only not a chimpanzee, but also that it is not at all closely allied to the chimpanzee, and that it has many characters that prove it to be near to the human ancestor.

In 1929 Dart removed the lower jaw from the upper and revealed for the first time the occlusal surfaces of the crowns of the milk molars. The side view of these teeth had shown that they were markedly different from those of the chimpanzee and gorilla, and were very like those of man. The occlusal surfaces now fully confirmed this view. They showed that Australopithecus cannot be nearly allied to any of the living anthropoids.

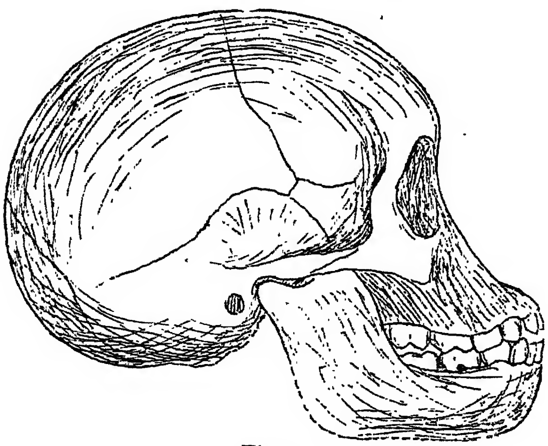

Fig. 1.
SIDE VIEW OF SKULL OF *Australopithecus africanus* DART. ½ NATURAL SIZE.

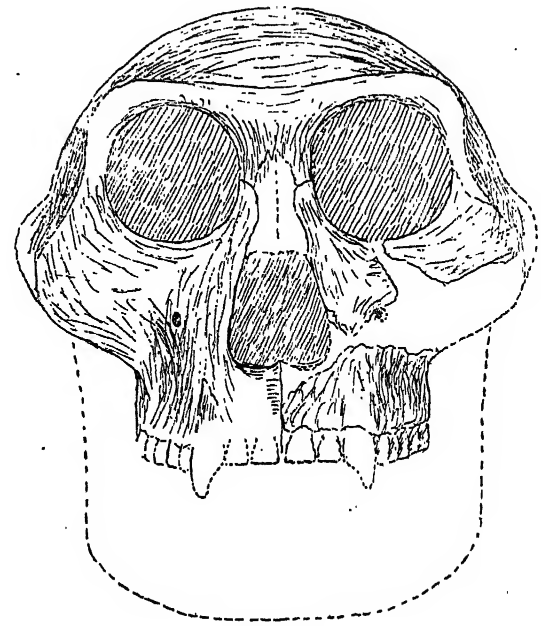

Fig. 2.
FRONT VIEW OF FACE OF *Plesianthropus transvaalensis* (BROOM). ½ NATURAL SIZE. THE PARTS SHADED ARE KNOWN IN THE TYPE. THE MANDIBLE IS UNKNOWN IN THE TYPE, BUT CONSIDERABLE PORTIONS ARE KNOWN IN OTHER SPECIMENS.

The first upper milk molars in the gorilla and chimpanzee have two main cusps. In man there are three; and Australopithecus agrees with man. The first lower milk molar in the gorilla is a flattened tooth with one large pointed median cusp and indications of small anterior and posterior cusps. In fact, it is not unlike the premolars of the dog. In man the first lower milk molar is entirely different. It is a molariform tooth with four well-marked cusps. In Australopithecus the tooth agrees closely with that of man. In the chimpanzee the tooth is like that of the gorilla with some rudiments of the ancestral condition. By no possibility can man have been derived from an anthropoid with degenerate and specialized teeth like those of the gorilla or chimpanzee. The four cusps which we find in man and Australopithecus are manifestly the four cusps found in the milk molars of the cercopithecids, such as the baboon. Man must have come from an anthropoid which still retained the cercopithecid type of

milk molars; and must have had a remote cercopithecid ancestor.

We need not here discuss the brain of Australopithecus. Dart and Elliot Smith considered that it showed some strikingly human characters; others thought the case not proved. Dart even went so far as to maintain that the structure of the brain showed that it was a bipedal animal, like man.

As Dart's type was only the skull of a young child-ape, the world remained unconvinced, and wanted an adult skull. So in 1936 I set about looking for one, and in a few weeks was successful; and not only got one, but parts of three others with many isolated teeth. Then in 1938 I got a good skull of what I consider to be a third new genus of man-like ape.

For many months I have been working at the Sterkfontein type skull, and have now completed a reconstruction of it; and it seems but right to reveal at the earliest possible moment how this anthropoid looked. I shall not here discuss at length my reasons for regarding this Sterkfontein ape as belonging to a distinct genus from Australopithecus. Manifestly the two forms belong to very different geological ages. The Sterkfontein, which I call the *Plesianthropus transvaalensis*, is probably of Middle Pleistocene age. The Taungs ape is almost certainly very much older. Probably it belongs to the Lower Pleistocene, but just possibly it may be Upper Pliocene.

Plesianthropus, as will be seen from the illustrations, has a skull somewhat like that of the chimpanzee in size, but differing greatly in many characters. Though the skull is that of a male, the canine, though fairly large, is unlike that of the chimpanzee, and there is practically no diastema between it and the second incisor. The cheeks are broad and more like those of the gorilla and orang than those of the chimpanzee. The nasal bones are only partly known, but from the upper parts of the maxillæ we can be confident that the nose must have been more man-like than ape-like.

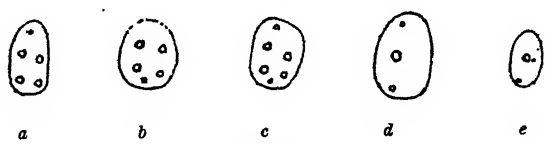

Fig. 3.

DIAGRAMS OF THE CUSPS IN THE FIRST LEFT LOWER MILK MOLARS IN VARIOUS PRIMATES. *a*, BABOON; *b*, AUSTRALOPITHECUS; *c*, BUSHMAN CHILD; *d*, GORILLA; *e*, CHIMPANZEE (ALL NATURAL SIZE).

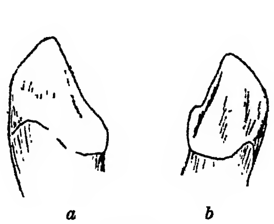

Fig. 4.

INNER SIDES OF LOWER CANINES OF ANTHROPOIDS (NATURAL SIZE). *a*, CANINE FROM YUNNAN, REGARDED BY WEIDENREICH AS CANINE OF AN ORANG, BUT BY THE WRITER AS MORE PROBABLY AUSTRALOPITHECINE CANINE AND POSSIBLY THE CANINE OF GIGANTOPITHECUS (FROM CAST); *b*, CANINE OF MALE *Plesianthropus transvaalensis*.

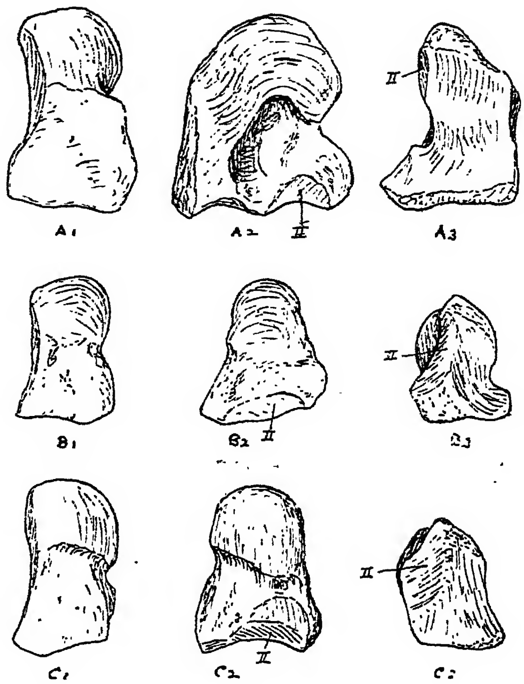

Fig. 5.

THE OS CAPITATUM (OR OS MAGNUM) OF THE CHIMPANZEE *A*1, *A*2 AND *A*3; OF THE STERKFONTEIN APE *B*1, *B*2 AND *B*3; AND OF THE BUSHMAN *C*1, *C*2 AND *C*3. DORSAL, RADIAL AND DISTAL SIDES. THE ARTICULAR SURFACES INDICATED BY II ARE THOSE FOR THE IIND METACARPALS.

The teeth, though a little larger than those of man, are almost typically human, and not very like those of either the chimpanzee or gorilla (Figs. 3 and 4).

The most interesting tooth in Plesianthropus is the lower canine. It is of a type almost unique. It differs markedly from the lower canines of the living anthropoids, and there are no known fossil canines at all like it, except one. On the posterior border of the tooth there is a very distinct small cusp with, in front of it on the outer side, a moderately deep vertical groove, and on the inner side in front of it a very deep groove. This little cusp is a typical cercopithecid character lost in all known anthropoids, except one. Weidenreich figures a lower canine from a cave at Yunnan which he refers to a "fossil orang". In my opinion this is unlikely to be the canine of an orang.

Von Königswald has described some teeth of a

large anthropoid under the name *Gigantopithecus blacki*. These were found in Chinese drug stores, and are believed to have come from somewhere in southern China (possibly Yunnan). One of these teeth, a second upper molar, so closely resembles the molars of the Kromdraai skull, Paranthropus, though very much larger, as to suggest that Gigantopithecus will prove to be an Australopithecine. Possibly Weidenreich's supposed fossil orang tooth came from the same locality, and will prove to be the lower canine of Gigantopithecus. In any event it is a tooth essentially similar in structure to the lower canine of Plesianthropus, and thus most probably an Australopithecine canine. Occasionally in man we find distinct evidence of this cercopithecid cusp, but usually it is lost in man as in the living anthropoids.

As I have recently shown, Plesianthropus has a maxillary antrum, which is fairly similar to that of man, and not at all like that of the chimpanzee.

The lower end of a femur which we may regard as practically certainly that of Plesianthropus closely resembles the femur of the Bushman, and is not like that of any of the living anthropoids. The only known wrist bone is very similar to that of a Bushwoman and differs greatly from that of the chimpanzee. I recently gave a figure of this os magnum or os capitatum, and for comparison the corresponding bones in some other Primates. Unfortunately, the supposed chimpanzee bone figured is really that of the orang. I therefore give a few other figures to avoid any possible confusion. Curiously enough the chimpanzee bone is less like that of Plesianthropus than is that of the orang, and it is distinctly more baboon-like, though it has no os centrale (see Fig. 5).

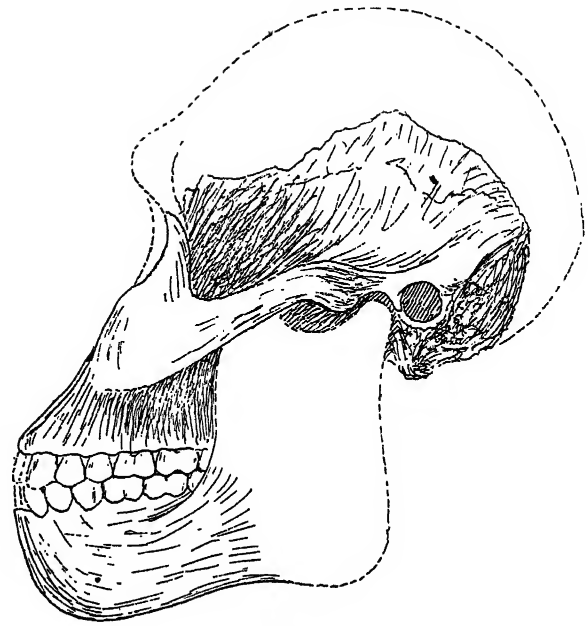

Fig. 7.
SIDE VIEW OF THE KROMDRAAI SKULL, *Paranthropus robustus* (BROOM). APPROX. 3/7 NATURAL SIZE. THE SKULL IS PROBABLY THAT OF A MALE.

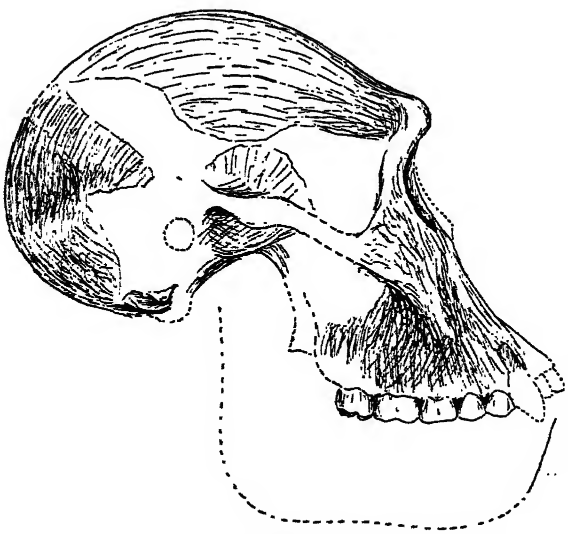

Fig. 6.
SIDE VIEW OF SKULL OF *Plesianthropus transvaalensis* (BROOM). APPROX. 3/7 NAT. SIZE. THE PARTS SHADED ARE ALL KNOWN IN THE TYPE SPECIMEN. TWO OF THE TEETH ARE DRAWN FROM THOSE OF THE LEFT SIDE. THE SKULL IS THAT OF A MALE.

In neither the orang, the gorilla nor the chimpanzee is the os capitatum like that in man. One very important difference is that in man the distal end of the bone gives a large articulation to the second metacarpal. In the chimpanzee and gorilla the distal end gives no articulation to the second metacarpal in the specimens I have examined, but there is a small articulation for it on the radial side. In the orang there is a similar radial articulation and a small distal articulation. In Plesianthropus the condition is essentially as in man, with a large articulation on the distal end for the second metacarpal. Probably the large articulation for the second metacarpal in man is due to the greater development of the metacarpal in connexion with the well-developed thumb. In the orang the thumb is better developed than in the gorilla and chimpanzee, and here there is a small distal articulation on the os capitatum for the second metacarpal. We are perhaps justified in concluding from the structure of the os capitatum in Plesianthropus that it, like man, had a useful opposable thumb.

The Kromdraai ape, *Paranthropus robustus*, is a third type of South African Australopithecid. It differs in many characters from Plesianthropus. It has a smaller canine and a very differently shaped face, and the premolars are much larger and differently shaped. It is also of a different geological age. The baboons associated with it

are of different species from those at Sterkfontein, and so are the species of Procavia. Though probably of Middle Pleistocene age, it may be many thousands of years older than Plesianthropus.

The skull gives us the perfect glenoid cavity which is almost typically human in structure, and quite unlike that of either the chimpanzee or the gorilla. The brain is probably considerably larger than that of Plesianthropus. Though only some fragments of the mandible of Plesianthropus are known, we have a good lower jaw of Paranthropus. Its teeth are almost typically human, but the premolars are very large ; while the canines are remarkably small.

We have the distal end of the humerus and the proximal end of the ulna of Paranthropus. These were found with the type skull, and there cannot be the slightest doubt that they belong to the same individual. They are almost typically human in structure, and very unlike those of the living anthropoids.

The South African caves have shown us that there lived in Pleistocene times various anthropoids which in many characters were much nearer to man than the living anthropoids. They had larger brains, and almost the human type of teeth, and there is considerable reason to believe they were mainly bipedal. They certainly were not arboreal, and they probably hunted in packs. There is reason to believe that they used sticks or stones for digging and as weapons. We can scarcely doubt that, though not yet human, they were nearly related to man.

Man was undoubtedly on the earth in Upper Pliocene times and must thus have been living in Europe and Asia when the known Australopithecines were inhabiting South Africa. Though it is thus improbable that any of the known South African Australopithecines can have been the ancestors of man, the discovery of these very man-like anthropoids shows us that there once lived a group of anthropoids so near to man in structure that we seem forced to believe that man has come from a Pliocene Australopithecine.

Though the gorilla is well removed from man's ancestor, he must be more nearly related to man than is the chimpanzee. Man and Australopithecus have retained a number of cercopithecid characters lost in the living anthropoids, but manifestly the gorilla and chimpanzee must have had cercopithecid ancestors. The cercopithecids have very marked ischial callosities. These are retained in the gibbons, and are occasionally well marked in the chimpanzee, but are lost in the orang, the gorilla and man.

Some years ago I argued that man must have sprung from a heavily built anthropoid such as the gorilla, which had to use its hallux for support, otherwise he would have lost his great toe, as has the kangaroo to-day. If I am right in assuming that Gigantopithecus was probably an Australopithecid we have perhaps in this giant form an anthropoid very near to that from which man arose.

The structure of the teeth in man and the Australopithecines seems to prove conclusively that man and the anthropoids must have come through a cercopithecid line as they have cercopithecid characters not found in the lemurs or the tarsioids. The living anthropoids have lost many of the cercopithecid tooth characters, but the orang retains sufficient to leave no doubt of the cercopithecid ancestry.

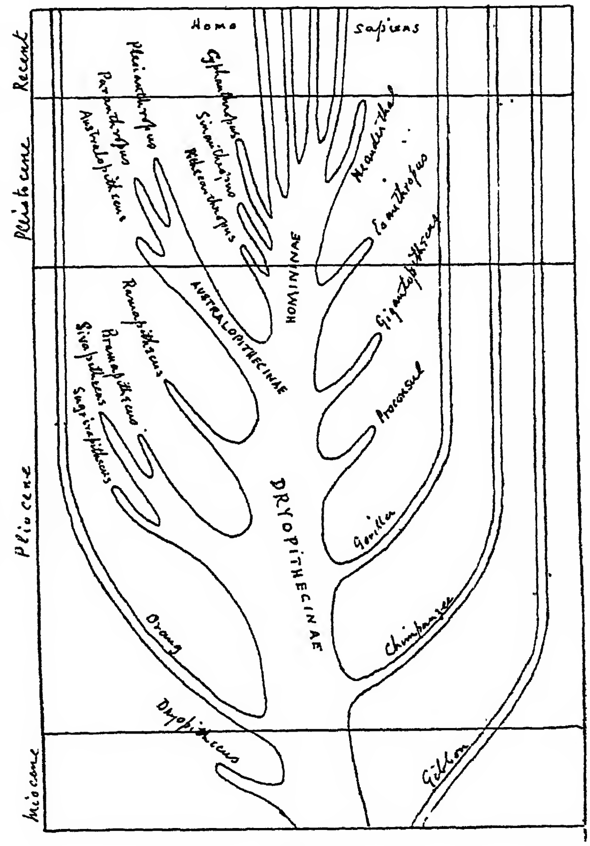

Fig. 8.

Phylogenetic relationships of man and the higher anthropoids.

I think there can be no reasonable doubt that man arose in Middle or more probably Upper Pliocene times from a large Australopithecine ape. The known Australopithecines are near relatives of this ancestor. The living anthropoids are much more remote relatives.

Though there are many who object to genealogical trees—and certainly some of those that have been published have been unsatisfactory—some-one must be correct ; and the one I here give may

with further knowledge have to be modified, but I think it cannot be very far from the truth.

In the tree I give, attention may be directed to the placing of Ramapithecus nearer to the base of the human stem than the other Siwalik types, and to the placing of Proconsul higher up than is usually done. Hopwood regards Proconsul as a Lower Miocene form "related to *Dryopithecus* and ancestral to the chimpanzee". I have only seen the cast, but incline to place it nearer to the gorilla, and appreciably higher. Possibly the supposed Miocene age is wrong.

The reasons for the various conclusions to which I have come will be given at length in the long paper I have in hand on the South African Pleistocene Anthropoids.

A NEW PROCESS FOR LIQUEFYING AIR

BY J. H. AWBERY

IN nearly all refrigeration processes, whether for the moderate cooling associated with food preservation or for the liquefaction of the 'permanent' gases, the operations are basically similar. A gas or vapour is compressed, the heat due to this compression is removed, and the fluid then allowed to expand, whereby it cools below the temperature of its surroundings. In the Linde process for making liquid air, the compression is to about 200 atmospheres, and the expansion takes place through a nozzle, the resulting cooling being that due to the Joule-Thomson effect ; the process is made cumulative by using the cold air to lower the temperature of the air which is still approaching the nozzle. Now the Joule-Thomson effect is by no means large in gases so nearly perfect as air, and it has long been realized that much greater cooling could be obtained in the expansion if this could be carried out in such a way that the gas did work, so that more energy would be removed from it. Mechanical difficulties, such as that of lubrication and of avoiding excessive heating due to friction, have caused designers to favour the theoretically less efficient expansion valve, though Claude had successfully applied the principle as early as 1906.

In an article in *Voks Bulletin* (November–December, 1940), Prof. P. Kapitza gives a brief description of an installation which has now been set up at the Institute of Physical Problems of the Academy of Sciences of the U.S.S.R., in which the expanding air does work by driving a turbine. The increased temperature-fall, as compared with free expansion through a nozzle, is so great that the initial compression need only be of the order of 5 atmospheres, instead of the 200 atmospheres necessary in Linde's process.

The main difficulty to be overcome was the design of the turbine itself, which is quite inefficient if the axial-flow impulse turbine used with steam is taken as a model. Owing to the low temperature, the air flowing through the turbine has a density five times that of steam at 250° C., so that there is a considerable centrifugal force as the fluid whirls around, and this must be taken into account, just as it is in a water turbine.

The present apparatus, which will be followed by larger ones, has a piston compressor working at 400 r.p.m., taking 50–80 kw. of electrical energy and delivering nearly 600 kgm. of air per hour at about 7 atmospheres. The compressed air then passes a water cooler and through the regenerator (cooled by previously treated air) to the turbine. The latter works at 40,000 r.p.m. and yields 4 kwh. of mechanical energy. The pressure drop is 4 to 1, and the cooling is such that air entering at – 158° C. emerges at – 187° C. (the boiling point of oxygen), implying the extraction of 3,700 calories per hour. The efficiency is thus 0·79–0·83. The regenerators also offer some novel features. There are two of them, used intermittently for about 26 sec. each, the change-over being effected automatically. They are filled with flat ribbon, 0·1 mm. thick and 50 mm. wide, with nodules.

From the turbine, the main air-stream is passed through the inner tubes of a condenser, only a small by-passed stream flowing through the outer tubes and being liquefied therein. The overall efficiency of the apparatus is such that it gives 29–30 kgm. of liquid air per hour, at an energy cost of 1·7 kwh. per kgm. It is calculated that this can be reduced to 1·2 kwh. per kgm. by making use of the mechanical energy from the turbine and by more suitable valves and other equipment, so as to utilize the full seven atmospheres compression, instead of only four-sevenths of it. If so, the apparatus will have about the same efficiency as present high-pressure installations.

It is even hoped that by working on a much larger scale, where heat losses are relatively smaller, the efficiency may rise to 1·1 or even 1·0 kwh. per kgm. of liquid air. In any event, as a laboratory installation, the outfit has many advantages, noteworthy among them being the short starting period (20 minutes or less) and the small dimensions, due to absence of decarbonizers, scrubbers, desiccators and other auxiliary gear.

THE SEARCH FOR ECONOMIC PLANTS*

By SIR ARTHUR W. HILL, K.C.M.G., F.R.S.
DIRECTOR, ROYAL BOTANIC GARDENS, KEW

THE search for plants yielding spices and the history of their cultivation and use, as well as the story of the transport of the spices, is a romance which includes accounts of geographical discovery, monopolies, economic warfare, annexations of territories, and all the vices of theft, envy, hatred and malice, and all uncharitableness enumerated by the Apostle St. Paul.

Perhaps the spice which should be put in the forefront is pepper (*Piper nigrum*), native of Malabar and of the forests of Travancore, a spice now too seldom seen or appreciated in its natural condition as black pepper corns, which was the staple article of trade between Europe and India for many ages. Most people to-day use white pepper, which is the small berry-like fruit or peppercorn, ground after its pericarp has been removed, thus depriving it of some of its pungency and best seasoning qualities.

Pepper was well known to Theophrastus in the fourth century, B.C., and to Dioscorides and Pliny, the former stating it to be a product of India. Its export from Baraké on the Malabar coast, near Calicut, is recorded in A.D. 64, and black pepper is one of the spices on which the Romans levied duty at Alexandria about A.D. 176. The first particulars we have, that it was a climbing plant "sticking close to high trees like a vine", occur in the writings of Cosmas Indicopleustes, a merchant and later a monk, who wrote about A.D. 540.

The wealth of Venice and Genoa largely depended on this spice, for tribute was levied in pepper, when money was scarce; it was often enacted that rents should be paid partly in pepper, and the Easterlings, according to the Statutes of Ethelred (A.D. 978–1016), coming in their ships to Billingsgate, had to pay at Christmas and Easter for the privilege of trading with London, a small tribute of cloth, five pairs of gloves, ten pounds of pepper and two barrels of vinegar. Now the only survival of this practice is the 'peppercorn rent', which signifies a merely nominal payment. The merchants who trafficked in spices in England were known as pepperers, and existed as a guild in the reign of Henry II and later were incorporated in the Grocers' Company.

Pepper, gums, myrrh, frankincense and cardamoms reached Europe mainly either by the Persian Gulf through Mesopotamia and Syria to the Levant or by the Red Sea and the Gulf of Suez and thence overland to Alexandria, while some consignments were conveyed by Arabian or Chinese traders to a port in southern Arabia and thence overland by the Frankincense route via Petra to Gaza and to Acre. From Alexandria or from the Levantine ports to which the spices had come overland they were shipped in the days of the Roman Empire to Rome, and later to Venice or Genoa, which cities for so many years held the monopoly of the traffic in spices.

During the Middle Ages the price of pepper was exorbitant. The high cost of pepper was one of the main inducements to the Portuguese to search for a sea passage to India, in order to break down the Venetian monopoly in this and other spices. Vasco da Gama anchored off Calicut in May 1498, and thus to pepper very largely, therefore, may be attributed the discovery of the Cape of Good Hope.

About the year 1500 the cultivation of pepper was taken up in the western islands of the Malayan Archipelago, especially in the islands of Rhio and Penang, and in Johore. The Dutch East Indies, Singapore, Penang, Ceylon, India and Indo-China are now the chief sources of supply.

The Venetians made every effort to retain the valuable traffic in their own hands, but in 1522, the first consignment of pepper reached Antwerp direct from India in a Portuguese ship, and the trade continued to be a monopoly of the Crown of Portugal until the eighteenth century. With the development of the all-sea route the overland traffic gradually came to an end. With regard to India, the century of Portuguese conquest of the west coast may be recalled, then their ousting by the Dutch, and finally, British dominion under the East India Company, and the efforts of the French and Danes to secure a share in the lucrative trade. Pepper thus was one of the principal economic products which has not only greatly enriched those who have held monopolies in its traffic, but has also incited geographical discovery, resulting in wars to secure possession of its native country.

Cloves, cinnamon, cassia, nutmegs and mace each have a history in which high enterprise, warfare, subterfuge and theft have all played their part.

Cloves are the dried flower buds of *Eugenia caryophyllata*, which is said to be native only in the five small islands of the Moluccas proper

* The substance of a lecture delivered before the Royal Geographical Society.

(Ternate, Tidore, Mutir, Machian and Bachina). The tree was introduced to Amboyna before the arrival of the Portuguese and is still cultivated there and in some of the neighbouring islands. Cloves are probably one of the oldest known of the spices, for it was customary for the Chinese Court officers, under the Han Dynasty, 266 B.C., to hold cloves in their mouth before addressing the Sovereign, to give their breath an agreeable odour. Nicolo Conti, a Venetian merchant, 1424–48, discovered the source of origin, previous writers having assumed that the places whence the spice was shipped, Ceylon, Java, or Malacca, were the homes of the plant. To the Portuguese however we owe our first accurate localization and description of the clove-tree, furnished by Pigafetta, the companion of Magellan, as he saw it in 1521.

For nearly a century the Portuguese were in control of the Spice Islands and had the principal share in the clove trade, until 1605, when the Dutch took possession of the Moluccas, and attempted to control the trade. They tried to restrict the tree to the Amboyna Islands—as they did with the nutmeg—and destroyed trees that might be growing elsewhere. Supplies however managed to reach England independently, though the Dutch monopoly was nearly complete until the latter end of the eighteenth century. Intrigue and theft apparently have played a very important part in the history of the clove in more recent times, for in 1770, the Governor of Mauritius and Bourbon, M. Poivre, procured living plants, both of cloves and nutmegs, and established them in those islands. The clove industry of Zanzibar and Pemba is due to an Arab from Zanzibar, who managed to obtain plants in Mauritius and took them about the end of the eighteenth century to his own island. Great Britain also took her share in what were probably illicit introductions of the spice plants, for, after Penang was founded in 1786 by Captain Light, the East India Company deputed Christopher Smith—one of the Kew collectors sent out by Sir Joseph Banks and George III—to visit the Moluccas and bring back spice plants (cloves and nutmegs) for cultivation.

The cultivation of cloves is now being extensively developed in Madagascar, which may prove a menace to the industry of Zanzibar and Pemba.

One of the present-day problems of economic plants relates to cloves, since the trees in Zanzibar are affected by a die-back disease, which demands careful research into ways of combating the malady and possibly of finding forms or varieties that may be resistant.

Nutmegs, *Myristica moschata*, are natives of the eastern islands of the Moluccas (Ceram, Banda) and of New Guinea. Nutmegs and mace, the crimson network arillus surrounding the nut, were imported into India at an early date by the Arabians and thus reached the West.

The home of the nutmeg was mentioned by Masudi about A.D. 918, and by the middle of the twelfth century nutmegs and mace were being imported to Aden, and duty on them was being levied at Acre about A.D. 1180. Ten years later they, with other aromatic products, were used in fumigating the streets of Rome at the coronation of the Emperor Henry VI. By the end of the twelfth century, nutmegs and mace were well known in Europe, but very costly, for about 1284, 1 lb. of mace cost 4*s*. 7*d*., the value then of three sheep or half as much as a cow. The Portuguese discovered the plant in Banda in 1572 and held the trade until they were driven out by the Dutch. The Dutch tried to restrict the trees to Banda and Amboyna by destroying the trees in all the other islands. In this however they appear to have been frustrated by pigeons, which swallowed the seeds and deposited them in neighbouring islands.

Great Britain occupied the Spice Islands during 1796–1802, and thanks to Christopher Smith's mission and the activities of Sir Stamford Raffles, nutmegs and cloves were introduced to Bencollen (Sumatra) and Penang. Plants were sent to Kew about that time and thence to St. Vincent and Grenada, where nutmegs now flourish.

Cinnamon (*Cinnamomum zeylanicum*), native of Ceylon, and cassia bark, the product of *Cinnamomum cassia* from southern China, are probably the earliest known of the spices. Frequent references occur to them in the Bible, and Theophrastus, Herodotus, Dioscorides, and other ancient writers refer to them as precious odoriferous substances. Cassia is mentioned in the earliest Chinese herbal, about the year 2700 B.C. To the Chinese may almost certainly be attributed the discovery of cinnamon in Ceylon, since they traded to Ceylon in very early times, and were no doubt familiar with the Chinese cassia-yielding species of Cinnamomum, which is very similar in appearance to the true cinnamon of Ceylon. An Arab writer, Kazwini, mentions cinnamon as a product of Ceylon in 1275, as do Ibn Batuta, the Muhammadan traveller, 1340, and Nicolo Conti, a hundred years later. The Portuguese discovered Ceylon after circumnavigating the Cape, and occupied the island on account of the cinnamon. Then the Dutch captured Ceylon, again because of cinnamon, about 1656, and established a monopoly in the spice, burning, as they did nutmegs, the stocks in Holland when the supply was greater than the demand. The English took Ceylon from the Dutch in 1796, and the East India Company held the monopoly in cinnamon until 1833.

(*To be continued.*)

OBITUARIES

Prof. F. Aveling

PROF. FRANCIS AVELING, professor of psychology in King's College, London, died on March 6, aged sixty-five.

The distinctive place in the development of British psychology which the late Prof. Aveling held, resulted from the rigorous training in philosophy to which he submitted himself before taking up his main work. Many others of his generation had reached psychology by the same route, but few have so succeeded in bringing their earlier discipline to bear fruitfully upon an empirical science. His study of the scholastic writers had given him a passion for precision and definiteness of thought, but never tempted him to forsake the experimental path for the *a priori*. His views were always as clear and hard in outline as one would expect from a student of St. Thomas, yet he was ready to modify them at any time when new evidence was presented.

Aveling was generous to a fault in his appreciation of the work of others. He could not believe that honest and persistent scientific effort could fail to reach at least partial truth, and in his later years some of his most interesting work lay in an attempt to evaluate the work of schools whose tenets were apparently opposed to those he held, believing it possible to show that their theories were not so much antagonistic as complementary to his own. He ascribed to controversial opponents his own obstinate integrity of mind, and was convinced that they could not have missed the mark completely. In the same spirit he always tried to relate his researches to those of others, believing that progress depended more on co-operation than on claims to originality. At the end of his life his views and sympathies (never narrow) were so broadening that one fears that his finest work remains undone.

His philosophical interests were probably responsible for the direction taken by his most important researches. His fine work on the "Consciousness of the Universal" was directed to the old problem of how the mind can achieve general thought, when all its process, as dated events, must be particular. This he approached in the light of the researches of the Würzburg school. After the interruption due to the War of 1914–18, in which he saw service, his work in this field was resumed by his pupils, who probably carried the study of the phenomenology of thinking as far as it is likely to go. From this he passed to volition, and an important series of studies were carried out in his laboratory. Here, too, his philosophical training is evident in his resolute facing of difficult theoretical problems, when he was driven to distinguish sharply conation from the decisive direction of effort exercised by the self. This work was summarized in "Personality and Will".

A little earlier he had published the "Psychological Approach to Reality," in which he applied the noegenetic principles of Spearman to the refutation of solipsism. But though his love of philosophy may have determined his own contributions to psychology it did not limit his activities. Only those who knew his laboratory well can properly appreciate Aveling's work. An enormous range of research was carried on there by his pupils, extending from elaborate experimental studies of perception to social psychology, each piece of work being designed to link on to other work in progress there or elsewhere. Much ingenious apparatus was designed and made in those cramped, inconvenient rooms. He popularized the tachogram method of experimentation on the psycho-galvanic reflex.

But the most lasting memory, and the truest, is of Aveling among his enthusiastic pupils, upon whom he bestowed so much affection, and so large a measure of his energy.

A. W. WOLTERS.

Mrs. H. H. Brindley

THE sudden and untimely death on April 3 of Mrs. H. H. Brindley has deprived us not only of an able entomologist but also of one of the most accomplished field ornithologists of her generation.

Maud Doria Haviland was a great-granddaughter of the famous Dr. John Haviland, professor of anatomy and then regius professor of physic at Cambridge from 1814 until 1851. She spent a large part of her early life in south-eastern Ireland, and it was here as a schoolgirl that the love of birds and wild animals developed. Although her outlook at first was that of the sportsman and field naturalist (she was a keen rider to hounds and a good shot), she was soon teaching herself vertebrate anatomy from text-books and taking every opportunity to practise dissection. Scientific publication began in 1913 with papers on ornithological subjects. In 1914 she went to Siberia as naturalist to a small anthropological expedition from Oxford, and this resulted in a delightful traveller-naturalist book "A Summer on the Yenesei" (1915). The war years 1914–18 were crowded with varied activities: residence at Cambridge, where she mastered the more technical aspects of biology with remarkable facility; driving a motor lorry over the rude tracks of the Bessarabian steppe, where she acted as chauffeur to a contingent of the Scottish Women's Hospital; and ambulance driving in the Paris-Soissons region for the French Red Cross. This period culminated in her election to a research fellowship at Newnham College in 1919, held until her marriage in 1922 to Mr. H. H. Brindley, fellow of St. John's College,

That Mrs. Brindley was a first-class field ornithologist her numerous papers show clearly. But she was also an entomologist of real ability. She published several valuable papers on the bionomics and post-embryonic development of various minute chalcid and cynipid hyperparasites of aphids, and she also produced excellent systematic work on the Mem-

bracidæ (Hemiptera) on which group she was an acknowledged authority.

In 1922 she visited the rain forests of the Essequibo and Demarara Rivers in British Guiana, and this expedition was the climax of her career as a field naturalist. During all her travels her outlook had been that of the ecologist, and the experience of tropical conditions enabled her in 1924 to give a memorable course of lectures to the Tripos class in zoology on certain aspects of animal ecology. This course resulted in a book entitled "Forest, Steppe and Tundra: Studies in Animal Environment" (1926), which is of permanent value as a series of essays linking the then somewhat youthful science of animal ecology with the outlook of the field naturalist. In this book there is much which deserves frequent re-reading, passages full of sound sense and keen insight. Her vivid and individual style expresses much of the woman herself—the energetic personality with its intense joy in the beauty of living things, combined in such a rare way with a critical appreciation of the scientific problems of the interaction of animals with their environment. But how can one describe adequately the charm of her company, the kind-hearted sincerity of her friendship and the irresistible delight and gaiety of her conversation? She possessed a most whimsical humour, kindly yet penetrating, and her skill as a *raconteur* was incomparable. The sincere sympathy of a wide and varied circle of friends will go out to her husband and daughter. Her passing leaves a gap which cannot be filled.

W. H. THORPE.

Prof. H. Freundlich, For.Mem.R.S.

SUPPLEMENTING the notices referring to Prof. H. Freundlich, which appeared in NATURE of May 10, Prof. J. Traube writes:

I have been termed the founder of scientific *Kapillar-Chemie* (see, among other papers, Freundlich, "I. Traube, zum 70sten Geburtstag", *Kolloid-Zeitschrift*, **50**, 194; 1930). My papers are so nearly related to those of Freundlich, that I feel it a duty to write some words in memory of the man who has done such excellent work on colloid chemistry and especially on *Kapillar-Chemie*.

In view of Prof. Rideal's article, I must restrict myself to the special connexion between Freundlich's work and my own. Freundlich created the name "Traube's Rule". He directed special attention to this rule, and he was the first to recognize its importance.

More interesting is, perhaps, Freundlich's agreement with me with regard to the theory of solutions. I have at all times declared, in contradiction to van 't Hoff and Arrhenius, W. Ostwald and W. Nernst, that the well-known theory of van 't Hoff and Arrhenius is only partially right, that not the number of particles and ions only are to be considered, but especially the effect of the particles with regard to the surface tension, etc., and that the theory of solution is not so similar to the theory of gases as van 't Hoff supposed. I was very glad when I read in Freundlich's article written in honour of my seventieth birthday that Freundlich wrote, "es heisst nicht mehr 'entweder oder' sondern 'sowohl als auch'"; and when the editor of the journal, Wolfgang Ostwald, in deference to the memory of his father had suggested that certain changes in the article should be made, Freundlich replied, "In this case the changes would be made still more in favour of Professor Traube".

From a letter dated February 14, 1940, which Herbert Freundlich wrote to me from the United States, I was very glad to learn that he also had accepted my conception of the existence of different particles of liquids and gases above and below the critical temperature, which displaces the Andrews and van der Waals' theory of continuity. He recalled also that Prof. O. Mass in Montreal had acknowledged these ideas.

Prof. J. W. C. Gunn

THE death of Prof. John William Cormack Gunn at the age of fifty-two will prove a severe loss to the University of Cape Town, for he had occupied the chair of pharmacology since 1919, had done much to establish the medical school and in recent years had served as dean of the Faculty of Medicine.

An Orcadian by birth, Gunn took his medical degree at Edinburgh. He obtained several academic prizes, and after qualification devoted himself to teaching and research in pharmacology. He acted as assistant first at Edinburgh and then at University College, London. He served in the R.A.M.C. throughout the War of 1914–18 and on demobilization became lecturer at the Queen's University of Belfast. He left this post to take the chair at Cape Town in 1919. At Cape Town he carried out researches on the pharmacology of South African native plants and inspired research among many of his graduates.

As time went on, Gunn's energies were more and more absorbed in the administrative work connected with the rapidly growing School of Medicine. He showed a special aptitude for this work and was warden of the Medical Students' Residence, curator of the Wernher-Beit Medical Laboratories and dean of the Faculty of Medicine. Gunn's cheerful personality made him popular both as a teacher and as a colleague and his loss will be felt severely by a wide circle of friends both in South Africa and in Great Britain.

We offer our sympathy to his wife and two sons.

A. J. CLARK.

WE regret to announce the following deaths:

Sir David Wilson Barker, president during 1903–5 of the Royal Meteorological Society, on June 15, aged eighty-two.

Mr. C. W. Jeffries, director of the Royal Observatory, Hong-Kong, since 1932, on June 22.

Prof. Robert Robison, F.R.S., professor of biochemistry in the University of London and head of the Department of Biochemistry at the Lister Institute, on June 18, aged fifty-seven.

NEWS AND VIEWS

Prof. R. W. Wood, For. Mem. R.S.: Henry Draper Medallist

The Henry Draper Medal of the National Academy of Sciences awarded to Prof. R. W. Wood, of Johns Hopkins University, at the 1940 annual meeting of the Academy, in recognition of his contributions to astronomical physics, was presented to him during the annual meeting in April last. Prof. Wood's contributions in the field of physics have been many and varied, and in the field of astrophysics three important researches, among many others, stand out especially. The first is Wood's pioneer work on resonance radiation and its applications to solar and stellar spectroscopy. A second is his development and skilful use of absorption screens of many types for astronomical and spectroscopic photography. Finally, and perhaps more important of all for the future of astrophysics, are the remarkable advances he has made in the construction of diffraction gratings. The use of the grating to produce a spectrum has been limited hitherto almost wholly to the sun and to bright sources in the physical laboratory ; by selection and shaping of the point of his ruling diamond, Wood succeeded in throwing as much as one half of the incident light into a chosen order of the spectrum. In addition, he was the first to achieve excellent results in ruling gratings on films of aluminium evaporated on glass. As a result, a modern Wood grating with high concentration of light is one of the most effective instruments of research in stellar spectroscopy. It has made possible the analysis of the spectra of the brighter stars on a large scale, has opened up the almost unexplored ultra-violet region of stellar spectra, and has already led to discoveries of interest regarding the constitution of the gases in interstellar space.

Sir C. V. Raman, F.R.S.: Franklin Medallist

Dissemination of news in war-time is difficult and this somewhat belated intimation of the award of the Franklin Medal to Sir Venkata Raman is a result of the slowed-down process. It is good news, however, to hear that Raman has obtained this high honour "in recognition of his many brilliant contributions to physical science and of his leadership in the renaissance of scientific work and scientific education that has occurred in India during the last thirty years". Raman joins the very distinguished company of Franklin medallists, which includes Rutherford, Thomson, Marconi, Bragg, Planck, Arrhenius and T. W. Richards. Not only has Raman personally made important contributions to theoretical and experimental physical science, but he has also lit the torch of scientific research for a large number of his countrymen who are turning out much distinguished work.

Sir C. V. Raman has worked on many branches of physics—optics, acoustics, and more particularly on the light scattering, which, in his honour, is now almost universally referred to as Raman effect. His discovery of this effect in 1928 not only inspired its exploration by himself and his students, but also started physicists and physical chemists in every country of the world to investigate it. Through its investigation far-reaching conclusions regarding the structure of molecules can be adduced ; its utility and importance need not be stressed here, but are reflected in the large number of papers which have been, and continue to be, published on the subject. Raman has received many honours from learned societies and institutions and, in addition, a knighthood in 1929 and the Nobel Prize in physics in 1930. In congratulating Raman on his latest honour, we hope that he will continue for many years to exert his powerful influence in conducting and directing, with sustained distinction and success, the fundamental problems of physics in which he has so indelibly established his reputation.

Louis E. Levy Medal of the Franklin Institute

The Committee on Science and the Arts of the Franklin Institute has announced that the Louis E. Levy Medal will this year be presented jointly to Profs. John M. Lessels and Charles W. MacGregor, both of whom are associate professors in the Department of Mechanical Engineering, Massachusetts Institute of Technology, for their paper entitled "Combined Stress Experiments on a Nickel-Chrome Molybdenum Steel". The Levy Medal is awarded annually "to the author of a paper of especial merit, published in the Journal of The Franklin Institute, preference being given to one describing the author's experimental and theoretical researches in a subject of fundamental importance".

John Moyes Lessels was born in Dunfermline, Scotland, on February 5, 1888. He was educated at Herriot Watt College and the University of Glasgow. During 1920–31, he was manager of the mechanical division of the research laboratories of the Westinghouse Electric and Manufacturing Company at East Pittsburg, and afterwards he was engineering manager of the South Philadelphia works. Since 1936 he has been associate professor of mechanical engineering at the Massachusetts Institute of Technology. He is technical editor of the *Journal of Applied Mechanics*.

Charles Winters MacGregor was born in Dayton, Ohio, on May 25, 1908. He attended the Universities of Michigan and Pittsburg, and during 1929–34 he was a research engineer with the Westinghouse Electric and Manufacturing Company at East Pittsburg. In 1934 he went to the Massachusetts Institute of Technology as instructor in mechanical engineering, and was appointed assistant professor in 1937.

Invalids and 'Fortified' Flour

THE Medical Research Council has issued a statement dealing with a suggestion that invalids may be harmfully affected by the consumption of bread 'fortified' with calcium. The need for this supplement is brought about in two main ways: first, the wartime diet in Great Britain tends to be deficient in available calcium, especially since restrictions have been imposed upon the sale of milk and eggs; secondly, the high content of cereal foods in the diet increases the amount of calcium it is necessary to ingest, partly because most cereals are deficient in calcium but also because the phytic acid in cereals often prevents the body from making use of the calcium they contain. The Ministry of Food has asked the Food Rationing (Special Diets) Advisory Committee whether the addition of small supplements of calcium salts to flour would be in any way deleterious to invalids. In reply, the Food Rationing (Special Diets) Advisory Committee has expressed the opinion that "there is neither medical nor scientific evidence that the consumption of bread made from flour fortified by the addition of appropriate quantities of calcium salts is harmful to patients suffering from any type of disease". This opinion was based on the following considerations.

It has been proposed by the Accessory Food Factors Committee of the Lister Institute and of the Medical Research Council that 14 oz. of calcium carbonate be added to each 280 lb. of 85 per cent extracted flour and 7 oz. of calcium carbonate to each 280 lb. of white flour. Expressing these quantities in other terms, it can be said that 1 lb. of the 'fortified' 85 per cent extracted flour and 2 lb. of the 'fortified' white flour contain slightly less calcium that 1 pint of fresh milk. There can therefore be no objection to the use of this fortified flour on the grounds that it will result in the consumption by invalids of harmful amounts of calcium. It has been suggested, however, that it might have a deleterious effect upon certain invalids because the calcium added to it is in a form—calcium carbonate—different from that which exists naturally in food. This criticism appears to be ill-founded. There is direct evidence obtained on human beings that the calcium of calcium carbonate is as available to the body as that of calcium phosphate. In an easily assimilable food, such as milk, calcium is in the form of a combination with a phosphoric acid, a common normal component of animal tissues; in calcium carbonate, calcium is also present as the salt of an acid of widespread occurrence in living tissues. In both cases, the calcium is split off from the acid during the process of digestion, and is absorbed into the body in the same form in each case.

Effect of Cooking on Vitamins

VITAMINS are lost or destroyed in the preparation and cooking of greenstuffs by many of the methods now in common use. Some generalizations which summarize our knowledge of the behaviour in greenstuffs of the vitamins most likely to be affected in the course of preparing green vegetables for the table have been issued by the Accessory Food Factors Committee of the Medical Research Council (London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1). Some simple rules based on these generalizations are given and cooking methods for greenstuff are recommended. Fat-soluble vitamin A is unlikely to suffer damage; water-soluble vitamins B and C are the most likely to be lost in preparation and cooking for various reasons stated. Twelve practical rules for the conservation of vitamins in the preparation and cooking of green vegetables are also given, together with methods recommended which result in the least loss of vitamin C.

War Food Production Advisory Bulletins

THE Welsh Plant Breeding Station, Aberystwyth, has issued two further War Food Production Advisory Bulletins, No. 2, "Ley Farming" by Sir George Stapledon, and No. 3, "Herbage Seed Production" by G. Evans (price 1*s*. each). These publications are complementary one to the other, the first being an extension of the first bulletin of the series, while the second shows the farmer how he can raise the necessary seeds himself. After a general description of the nature of ley farming and how it differs from the permanent grass or the grass-arable systems, six methods of dealing with permanent grass are suggested which show how the change over to ley-farming can be effected from all grades of land. Care is taken to indicate where manures, particularly phosphates, can be most profitably applied. As regards seed production, the directions are based on the author's experiences in inspecting farms and conducting experiments in various parts of Great Britain, and there seems no reason why more farmers should not successfully raise their own seed than have done so in the past. A full knowledge of the recent history of the fields and adequate provision for their isolation are two essentials for the production of pure strains; climate and soil are also important, the former especially in the case of the clovers, while grasses make larger demands on the soil. Practical recommendations are given as regards sowing, manuring, times of harvesting, threshing, cleaning and storing, together with the yields likely to be obtained. The bulletin concludes with a list of the herbage strains bred by the station at Aberystwyth and a description of their special characteristics.

Town and Country Planning

THE forty-second annual report of the Town and Country Planning Association refers to a memorandum on "Town Planning in Relation to the Present Emergency and After-War Reconstruction" submitted to the Prime Minister last autumn, as well as to opportunities which Sir Montague Barlow, Prof. P. Abercrombie, Dr. W. A. Robson and other members have had of putting before Lord Reith and Mr. Arthur Greenwood the policy of national planning, decentralization, re-development and construction of new towns for which the Association stands. The

agreed findings of the report of the Royal Commission on the Geographical Distribution of the Industrial Population are substantially consistent with evidence given before the Commission by the Association and have proved of the utmost value as a basis for national policy. The Council is considering what forms of activity are practicable in present circumstances to use the new opportunities. The formation of groups, in as many towns as possible, which will undertake research and education in the local application of a national planning policy, is desirable. There is a great demand from men in the services and civilian groups for well-informed talks and booklets on future planning. Much also needs to be done to develop sound policy and technical knowledge among members of local authorities and their staffs. The report also directs attention to the change in name of the Association from "The Garden Cities and Town Planning Association", and includes a short statement of town–country planning principles, adopted by the Council in January 1941, acceptance of which by the Government and Parliament is urged.

These suggestions include the establishment of a Ministry, advised by a National Planning Council, to guide future development and re-development, and the future grouping of industry and population, to secure the best use of the land and to conserve the national resources in the general interest. The distinction between town and county should be maintained in all development, and sporadic building in rural areas discouraged. In particular, good food-growing land, places of special landscape beauty, and areas suitable for national parks or coastal reservations should be protected from ordinary building development. Good design and lay-out of buildings and roads as well as sound construction should be an object of policy. In rebuilding urban areas, the density of residential districts should be limited to provide sufficient open space, including reasonable garden space, and wide country belts should be reserved around all cities and towns. New developments required by industrial changes, decentralization from congested areas, or by the growth of towns up to their planned limits should be directed to other towns or to new towns carefully sited and planned. The Ministry charged with national planning should have power to prevent, except under licence, the settlement of new industrial undertakings in overgrown or congested towns and in undeveloped rural areas, and to offer inducements to industry to settle in suitably selected places. The inadequate provisions for compensation and betterment under the Town and Country Planning Act should be replaced by new legislation based on expert consideration before the conclusion of the War.

Soil Mechanics in Brazil

AMONG the papers contributed to the Third Reunion of the Brazilian National Laboratories for Testing Materials was one on soil stabilization, which has since been issued as a booklet by the National Institute of Technology, Rio de Janeiro. The author, Paulo Sá, outlines existing knowledge in this branch of the science of soil mechanics, in the hope of directing the attention of Brazilian engineers to this new and important science. This would be a commendable aspiration in any country. Too many engineers are unfamiliar with the extent to which the study of foundation and earthwork problems has been developed during the last ten or twenty years, for it is now legitimate to speak of the emergence of a rational science of soil mechanics, based on sound scientific principles and making full use of theory, experiment and practice. Here again, as in most cases of fresh scientific approach to an old problem, research has established a considerable lead on practical application. The Brazilian writer complains that, in his country, soil mechanics specialists are *muito poucos*: in Great Britain also they are all too few. But the subject is not only a matter for the specialist. It should become part of the training of all civil engineers. Emphasis has been laid on the need for greater attention to it in Great Britain in annual reports of the Building Research Board which, in its report for 1938, noted with satisfaction steps taken at several university institutions, following a conference at the Building Research Station, to bring the subject into greater prominence in the curriculum for engineering students.

Electric Heating in the Pottery Industry

THE new pottery factory of Messrs. Josiah Wedgwood and Sons, Ltd., at Barlaston, has been described in articles in the *Electric Review* of April 18 and May 2. For the first time in Great Britain, electrical biscuit and glost firing have been combined in one kiln. In biscuit firing the pottery is subjected to direct radiation from the source of heat instead of being stacked in the kiln in special containers (saggars). Both the biscuit and glost firing are effected in a double tunnel kiln of the conveyor type. The two tunnels—one biscuit and one glost—are side by side, so as to reduce construction costs and effect a measure of heat recuperation. In each tunnel there are a heating-up and a cooling-down section at opposite ends of the firing zone, and the sequence in the case of biscuit firing is opposite to that of glost firing. The overall length of the kiln is 272 ft. and the firing zone is about 100 ft. long. Each tunnel measures about 6 ft. by 4 ft. inside, just a little larger than the trucks which convey the wares through the kiln. The firing zone of each tunnel has a number of sections, the temperatures of which, as recorded by pyrometers on the outside walls and at the centres of the sections, follow a desired curve in each case, with a maximum in the case of biscuit firing of about 1,150° C. 'Kanthal' type or aluminium-iron elements consisting of strip about ½ in. wide wound spirally on a refractory former about 3 ft. long are used. Trucks carrying the pottery run on rails continuously through the kiln end to end as a train, the whole being propelled by a pusher unit, which operates with the end truck at the tunnel entrance. Enamelling firing for colour work demands a temperature of about 850° C., which

is low in comparison with biscuit and glost firing. The enamel firing is also done electrically, but this is not a new development although the kiln used for the purpose is new.

Jean Nicolas Corvisart (1755–1821)

In a recent paper (*Proc. Roy. Soc. Med.*, **34**, 239; 1941) on the life and times of Jean Nicolas Corvisart, after emphasizing the resemblance between the stirring events at the beginning of the nineteenth century and those at the present time, Dr. Halls Dally said that the genius of Laennec had almost eclipsed the glory of his teacher Corvisart, whom several biographers merely regarded as "First Physician to the Emperor Napoleon I". Corvisart, however, had greater claims to medical fame. He rescued the art of percussion invented by Auenbrugger from oblivion, perfected it, and was the father of cardiology. His great work on diseases of the heart and great vessels, which was published in 1806, marks the beginning of the clinical study of cardiology. His numerous distinguished pupils and successors included Bichat, the founder of biology, Bretonneau who discovered diphtheria, Bouillaud who first described the cardiac manifestations of rheumatic fever, Dupuytren who created the school of clinical surgery and Cruveilhier, the celebrated anatomist and pathologist.

Recent Earthquakes

A severe earthquake just before noon G.M.T. on June 26 had its epicentre near the Nicobar Islands in the Bay of Bengal, north-west of Sumatra. It is not yet known how many casualties or how much damage was caused, but only twelve of these British governed islands are inhabited. The amplitudes caused by the earthquake on the seismographs throughout the world were comparable to those caused by the Quetta and Turkish earthquakes.

Earthquakes on the same day were experienced in eastern Morocco causing considerable damage but few casualties.

The U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association has calculated the provisional epicentres of the earthquakes of April 1, 3 and 7. The first was south of the Alaskan Peninsula near 56·0° N., 153·0° W., at 10h. 41·1m. G.M.T. The second was in Chile near 25° S., 69° W. at 15h. 21m. G.M.T. with a depth of focus near 200 km. The third was in the Caribbean Sea south of Jamaica near 17·6° N., 78·3° W. at 23h. 29·3m. G.M.T. All are in well-known seismic regions.

Institute of Fuel: Students' Medal

To encourage the preparation of papers by students of fuel technology, the Council of the Institute of Fuel has decided to make an annual award of a medal, together with a prize consisting of books and/or instruments to the value of £5, for a paper submitted by a student member of the Institute or by a student less than twenty-five years of age of any university or technical college in the United Kingdom. The paper must deal with some subject relating to the preparation or utilization of fuel, or allied subjects. Papers must be submitted to the Secretary of the Institute under a *nom de plume*, the name and address of the author being enclosed in a sealed envelope and sent with the paper, and must be received by the Secretary on or before September 1 in any year. Further particulars can be obtained from the Secretary, Institute of Fuel, 30 Bramham Gardens, London, S.W.5.

Announcements

The Academy of Sciences of the U.S.S.R. has awarded the Pavlov Prize for 1940 to Prof. Maria K. Petrowa, professor at the Pavlov Institute of Physiology.

The Royal Swedish Academy of Science has elected Sir Thomas Lewis, physician-in-charge of the Department of Clinical Research at University College Hospital, London, a foreign member of the Faculty of Medical Research.

Miss Julia Bell, honorary Galton research fellow of University College, London, and member of the scientific staff of the Medical Research Council, has been awarded the Weldon Memorial Prize for 1941 of the University of Oxford.

Mr. Griffith Brewer has been elected president of the Royal Aeronautical Society for the year October 1941–September 1942; Prof. L. Bairstow, Mr. W. C. Devereux and the Right Hon. J. T. C. Moore-Brabazon have been elected vice-presidents for the same period.

Prof. Carl Neuberg, formerly professor in biochemistry in Berlin, Amsterdam and Jerusalem, has been appointed professor of biochemistry at the New York University College of Arts and Science.

The title of honorary reader in organic chemistry in the University of Leeds has been conferred upon Dr. J. W. Baker, lecturer in the Department of Organic Chemistry. Mr. T. G. Bridgwood has been appointed lecturer in electrical engineering.

The Council has agreed, on the recommendation of the Senate, that in general all men students of the University of seventeen and above should be required to become (if not already) members of the Senior Training Corps or the Air Training Squadron, or alternatively to undertake some other form of national service approved for the purpose.

A research scholarship of the value of £250 per annum and tenable for two years has been founded by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects and it is hoped to make the award in September 1941. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

A New Method for the Estimation of Trigonelline in Urine and Foodstuffs

THE recognition of trigonelline as a product of the metabolism of nicotinic acid is due to Ackermann[1], who in 1912 dosed dogs with nicotinic acid and found it to be partly excreted as trigonelline. Linneweh and Reinwein[2,3] isolated the latter substance from normal human urine, and found that the amount excreted was increased after the consumption of coffee. More recently Sarett, Perlzweig and Levy[4] reported that when human subjects were dosed with nicotinic acid, a portion of it, ranging from 10 to 15 per cent, was excreted as trigonelline. Melnick, Robinson and Field[5] have made similar observations. However, the exact relation between the excretion of trigonelline and intake of nicotinic acid remains to be investigated, and can only be settled after a satisfactory quantitative procedure for the estimation of trigonelline has been devised. The methods used by Sarett and his co-workers and by Melnick *et al.*, involve the conversion of trigonelline to nicotinic acid in the presence of strong alkali and ammonia. The conversion according to the former group of workers is 65–75 per cent, and according to the latter group 28–38 per cent. The amount converted seems to depend on the concentration of ammonium salts, the strength of alkali used, the length of hydrolysis, and possibly other factors, and the method at best is only semi-quantitative.

We have devised a new quantitative method for estimating trigonelline in urine and foodstuffs, based on the observation that when trigonelline is hydrolysed with alkali in alcoholic solutions, methylamine is split off, leaving the ring open. The resulting product can be combined with aromatic amines to give coloured compounds which can be measured quantitatively. Of a number of amines examined, we found benzidine to be the most satisfactory. It gives an orange-red derivative with the hydrolysed product, which seems to be specific for trigonelline. Pyridoxine (vitamin B_6), nicotinic acid, nipecotic acid and nicotine show no such reaction. The only other compound, so far as we are aware, which reacts similarly is *N*-methyl pyridinium hydroxide. By this method, $1 \cdot 0$ μ gm. of trigonelline per ml. of urine can be quantitatively estimated. The average recovery of added trigonelline to urine from eighteen trials was 95 per cent ($\pm$ 8 standard deviation). The procedure is as follows:

For urine: To 10 ml. of urine add ½ ml. of 40 per cent sodium hydroxide and heat on a boiling water-bath for twenty minutes. Cool, add 1 ml. of concentrated hydrochloric acid and 0·4 ml. of 10 per cent barium chloride solution, and then 40 ml. of 96 per cent ethanol. Add 0·5 gm. of Norite charcoal and shake for one minute. Filter and measure two 20 ml. portions of the filtrate into two 50 ml. conical flasks. To one of the flasks add 0·5 ml. of a standard trigonelline solution containing 50 mgm. per ml. Add 4·2 ml. of 40 per cent sodium hydroxide to each flask and heat on the water-bath for ½ hour. Cool, neutralize cautiously, and make up to 30 ml. Centrifuge, and measure two 10 ml. portions of the centrifugate into two test tubes, one for the blank and the other for the unknown. The blank should contain 1 ml. of 5 per cent hydrochloric acid, and the unknown 1 ml. of 1 per cent benzidine in 5 per cent hydrochloric acid. Allow one hour for the colour to develop, and then measure the colour in a Pulfrich photometer using filter number *S* 50.

For foodstuffs: With foodstuffs the preliminary digestion for twenty minutes is omitted. Measure 10 ml. of an extract of the material into a conical flask and treat with hydrochloric acid and barium chloride, and proceed as described above. In coffee and tea, 7·5 mgm./gm. and 0·13 mgm./gm. of trigonelline respectively were found.

The accompanying table shows some of the typical results obtained with urine.

EXCRETION OF TRIGONELLINE AND NICOTINIC ACID* BY A NORMAL INDIVIDUAL ON A COFFEE-FREE DIET AND AFTER DOSING WITH 50 MGM. AND 100 MGM. OF NICOTINIC ACID.

Description	Trigonelline excreted		Nicotinic acid excreted		Nicotinic acid + trigonelline total
	In mgm. per day	Increased excertion as % of nic. acid dosed	In mgm. per day	Increased excretion as % of nic. acid dosed	Increased excretion as % of nic. acid dosed
1st day—normal coffee-free diet	14·1	—	1·3	—	—
2nd ,, ,, ,, ,, ,,	11·0	—	1·1	—	—
1st day + 50 mgm. nicotinic acid	20·6	16·0	2·7	3·0	19·0
2nd ,, ,, ,, ,, ,,	21·5	18·0	2·2	2·0	20·0
1st day + 100 mgm. nicotinic acid	21·0	8·4	10·9	9·7	18·1
2nd ,, ,, ,, ,, ,,	34·3	31·7	11·3	10·1	41·8
3rd ,, ,, ,, ,, ,,	35·0	22·4	7·9	6·7	29·1
4th ,, ,, ,, ,, ,,	47·9	35·3	9·6	8·4	43·7
5th ,, ,, ,, ,, ,,	46·3	33·7	—	—	—
6th ,, ,, ,, ,, ,,	41·7	29·1	—	—	—

* By the modified method of Harris, Kodicek and Wang[6].

The excretion of trigonelline by normal individuals on a coffee-free diet ranged from 10 to 16 mgm. per day. After dosing with nicotinic acid the increased output of trigonelline varied from 10 to 28 per cent of the ingested dose, depending upon the size of the dose and the body weights of the subjects.

The metabolic connexion between trigonelline and nicotinic acid is of interest in relation to the test proposed for assessing the nutritional status of human subjects in the anti-pellagra vitamin (Harris and Raymond, 1939[7]). This depends on the measurement under controlled conditions of the urinary excretion of nicotinic acid or related substances. We have confirmed the conclusion of Harris and Raymond[7] that their method does measure essentially the nicotinic acid (which is biologically active), and that trigonelline (which is inactive), does not interfere. With the low concentration of alkali and the short period of hydrolysis used, no detectable amount of trigonelline is converted to nicotinic acid. The disadvantage of a prolonged digestion with stronger alkali, as used by Swaminathan[10], is that a considerable conversion of trigonelline into nicotinic acid occurs. The method of alkaline hydrolysis used by Harris and Raymond seems preferable to that of acid hydrolysis used by Melnick and Field[8], since the latter may involve an incomplete conversion of nicotinuric acid, and a darker digestion mixture. Also Melnick and Field[9], in criticizing the blank correction, seem to have overlooked the fact that the Cambridge workers employed an acid reaction medium, in which the urine reacts less with interfering substances than in the neutral medium used by Melnick and Field, and in which the bleaching effect of CNBr is entirely suppressed.

We have introduced certain modifications in the method of analysis which increase its sensitiveness and accuracy; these include the removal of interfering substances by preliminary adsorption on charcoal, control of period of hydrolysis and adjustments in the blank correction.

In conjunction with Dr. Harris we have confirmed again that the estimation of nicotinic acid, as such, in urine, in the absence of test-dosing (that is, measurement of 'resting level' of excretion) does give an indication of the past intake of nicotinic acid and hence of the anti-pellagra status of the subject: thus in deficiency in humans, in dogs and in guinea pigs the excretion of nicotinic acid falls either to zero or to a very low level[6]. Indeed, in ordinary circumstances it seems preferable to estimate the nicotinic acid rather than the trigonelline in a specimen of urine, because, unless special precautions have been taken to make the diet free of trigonelline, it may be excreted in large amounts as such in the urine, even when there has been no nicotinic acid in the diet and the subject is actually deficient. For test-dosing on the other hand ('saturation tests') the most satisfactory procedure would appear to be to administer nicotinamide and estimate both the trigonelline and the nicotinic acid excreted while the subject is kept on a controlled diet low in trigonelline. Our reason for this recommendation is the finding that when doses of nicotinic amide are given the product excreted in the urine is almost entirely trigonelline, while with a nicotinic acid dose both trigonelline and nicotinic acid (or nicotinic acid-like substances) are found. The possible explanation may be that nicotinic acid given by mouth has first to be converted by the organism into nicotinamide before being excreted as trigonelline, and any excess which escapes this conversion will be excreted as nicotinic acid-like substances. On the other hand, nicotinamide is utilized as such and there is no overflow of nicotinic acid-like substances, but only an increased excretion of trigonelline.

E. KODICEK.
Y. L. WANG.

University of Cambridge and
Medical Research Council,
Dunn Nutritional Laboratory,
Cambridge.
May 28.

[1] Ackermann, *Z. Biol.*, **59**, 17 (1912).
[2] Linneweh and Reinwein, *Z. physiol. Chem.*, **207**, 48 (1932).
[3] Linneweh and Reinwein, *ibid.*, **209**, 110 (1938).
[4] Sarett, Perlzweig and Levy, *J. Biol. Chem.*, **135**, 483 (1940).
[5] Melnick, Robinson and Field, *ibid.*, **136**, 131, 145 (1940).
[6] Harris, Kodicek and Wang, in the Press.
[7] Harris and Raymond, *Biochem. J.*, **33**, 2037 (1939).
[8] Melnick and Field, *J. Biol. Chem.*, **134**, 1 (1940).
[9] Melnick and Field, *ibid.*, **135**, 53 (1940).
[10] Swaminathan, *Ind. J. Med. Res.*, **27**, 417 (1939).

Sulphanilylguanidine

IN view of the present interest in the trial of sulphanilylguanidine for the treatment of bacillary dysenteries[1] it may be useful to direct attention to a convenient method for the preparation of this substance by the fusion of sulphanilamide with dicyandiamide which we described some years ago. In our original description of this reaction[2] it was assumed that the substance isolated was formed by the addition of the cyanamide group at the N4 position to give 4-sulphonamidophenylguanidine; $NH:(NH_2)CNHC_6H_4.SO_2NH_2$; actually addition takes place at the N1 position to give sulphanilylguanidine, $NH_2C_6H_4.SO_2NH.C(NH_2):NH$ completely identical with the product recently obtained by Marshall *et al.*[3] by the interaction of *p*-acetylaminobenzenesulphonyl chloride and guanidine. Marshall's synthesis leaves no doubt about the correct constitution of the substance, which is confirmed also by the insolubility of the substance in alkali and the development of colour on diazotizing and coupling.

We are much indebted to Prof. E. K. Marshall, jun., who has kindly directed our attention to the identity of the substance produced by these two reactions.

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SYDNEY SMITH.
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[1] Marshall, E. K., Bratton, A. C., Edwards, L. B., and Walker, E., *Bull. Johns Hopkins Hosp.*, **94** (January, 1941).
[2] Buttle, Dewing, Foster, Gray, Smith and Stephenson, *Biochem. J.*, **32**, 1101 (1938).
[3] Marshall, Bratton, White and Litchfield, *Bull. Johns Hopkins Hosp.*, **67**, 1f3 (1940).

Vitamin A in Canned Salmon

IN a communication in NATURE[1], Pyke and Wright have commented on the high values for the vitamin A contents of salmon-body and salmon-flesh oils given in the tables of Fixsen and Roscoe[2]. In their own experiments they have failed to detect any vitamin A by the antimony trichloride method

in twelve specimens of canned and two of chilled salmon flesh.

While the upper values quoted by Fixsen and Roscoe certainly seem beyond the range reported by most investigators, my own experience does not support the view of Pyke and Wright that canned salmon is quite devoid of vitamin A. In four specimens purchased locally, I have found 5, 120, 120 and 150 I.U. of vitamin A per 100 gm. of flesh by the antimony trichloride method, applied to the unsaponifiable fraction. These results agree with the findings of most previous workers that canned salmon contains small but appreciable amounts of vitamin A.

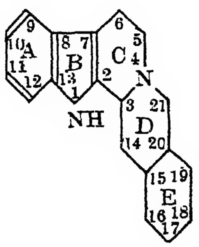
T. MOORE.

Nutritional Laboratory,
Cambridge.
May 16.

[1] Pyke, M., and Wright, M. D., NATURE, 147, 267 (1941).
[2] Fixsen, M. A. B., and Roscoe, M. H., *Nutrit. Abstr. Rev.*, 7, 823 (1937–38); 9, 795 (1939–40).

Constitution of Yohimbine

It has been suggested by D. G. Harvey, E. J. Miller and W. Robson in a recent publication[1] on the colour reactions of tryptophan and allied compounds—among them the alkaloid yohimbine—that the formation of a *blue* colour in sulphuric acid containing a trace of oxidizing agent is characteristic of the 4-carboxytetrahydro-β-carbolines. The presence in yohimbine of both tetrahydro-β-carboline and carboxylic acid (actually carbomethoxyl) residues has been recognized for some time, and it is clear from the formation in good yields of 2 : 3-dimethylbenzoic acid from ketodihydroyobyrine[2], and of harman and *m*-toluic acid from tetradehydroyohimbic acid[3], that the carbomethoxyl must be attached to the yohimbine skeleton, which is as depicted, in ring *E* at position 16.



Harvey, Miller and Robson do not, however, refer to this evidence, but conclude that the carbomethoxy-group is located at C_5 because the alkaloid displays a 'carboline-blue' colour reaction.

We have been engaged on experiments on the constitution of yohimbine, and by distilling yohimbic acid with copper and cupric oxide instead of alkali have improved Hahn's preparation of yohimbol[4]. The complete identity which we have observed between the sulphuric acid colour transformations of this *carboxyl-free* secondary alcohol and of yohimbine entirely invalidates the evidence on which the suggested alternative formula rests. With regard to the position of the alcoholic hydroxyl, which Hahn[5] disposes at C_{17}, it appears to us that the available evidence strongly favours its existence at C_{19}, and we propose for the alkaloid a structure having the groups $-CO_2Me$ and $-OH$ at positions 16 and 19 respectively.

M. J. S. DEWAR.
F. E. KING.

Dyson Perrins Laboratory,
Oxford.
June 4.

[1] *J. Chem. Soc.*, 153 (1941).
[2] Barger and Scholz, *Helv. chem. Acta*, 16, 1343 (1933).
[3] Hahn, Kappes and Ludewig, *Ber.*, 67, 686 (1934).
[4] Hahn and Stenner, *Ber.*, 61, 278 (1928).
[5] Hahn and Hansel, *Ber.*, 71, 2192 (1938).

Salaman's Culture of Blight Resistant 'Aya papa'

A FURTHER note may be of interest in connexion with Reddick's paper, "Whence came *Phytophthora infestans*?"[1], on the question of the distribution of blight resistant potatoes in the American continent.

Blight resistance has so far been found only in Mexico with the exception of a plant known as 'Aya papa' from Ecuador. Salaman's culture of this plant is immune, but Reddick considers that this is not the original Aya papa collected by P. T. Knappe but a *Solanum demissum* hybrid in about the first back-cross stage.

Cytological examinations of root tip preparations made by us from Salaman's Aya papa show that the specimen is a pentaploid with 60–62 somatic chromosomes. The chromosome number thus confirms Reddick's suggestion that Salaman's culture of Aya papa is a hybrid between *S. demissum* ($2n = 72$) and *S. tuberosum* ($2n = 48$). The plant also shows many morphological similarities to *S. demissum*, especially in such floral details as the short corolla lobes and characteristic 'star'.

We were at first inclined to consider that Knappe's original plant was also a *S. demissum* hybrid, but both Bukasov (see Reddick[1]) and Black (in a private communication), who obtained their cultures direct from Knappe, found it to be susceptible. Furthermore, their descriptions (Bukasov[2], Black, in a private communication) do not agree with Salaman's culture. A further piece of evidence comes from Ecuador itself. One of us (J. G. H.) when in Riobamba (whence Knappe was said to have obtained his tubers of Aya papa) was able to ascertain that potatoes known as Aya papa did actually occur in certain localities, growing apparently wild in the vicinity of native habitations and villages. They are regarded by the Indians as potatoes which were cultivated by their ancestors—hence the Quechua name 'Aya', which means 'dead person, ghost or ancestor' and 'papa', signifying 'potato'.

All evidence, therefore, points to the conclusion that Knappe's Ecuadorean potato was not blight resistant and that this quality has not yet been discovered outside Central Mexico.

J. G. HAWKES.
H. W. HOWARD.

School of Agriculture,
Cambridge.
June 14.

[1] Reddick, D., *Chronica Botanica*, 5, 410–12 (1939).
[2] Bukasov, S. M., Suppl. 58, *Bull. Appl. Bot. Leningrad*, 192 (1933).

The Recombination Law for Weak Ionization

IN order to explain the observed relation between the number of condensation nuclei in atmospheric air and the ionization, an equilibrium equation was proposed[1] of the type $q = an + bnZ$, where q is the rate of production of ion-pairs per cm., n and Z the concentrations of small ions (of one sign) and nuclei, and a and b are constants for any given conditions. This implies that, in atmospheric air, the rate of loss of ions by recombination among themselves is proportional to n and not to n^2. It was suggested that, where a volume of air is traversed at any time by only a few ionizing particles, the rate of loss of ions from the space by recombination is proportional to the number of ion tracks and hence approximately to n.

To test this view, experiments have been carried out on air free from nuclei contained in a vessel of volume 730 litres. The intensity of the ionization inside the vessel was varied by placing a small quantity of radium at different distances from it. Observations were made of n for different values of q. In experiments of this kind, ions are lost by diffusion as well as by recombination, and the chief difficulty is to make a proper allowance for this loss. In this work, correction for diffusion has been made on the lines developed by Power[2], and it is believed that the corrected values of n are fairly accurate.

Using corrected values of n, and plotting log n against log q, we obtain a graph the slope of which varies. For values of q between 360 and 120, the slope is 2·0, in agreement with the ordinary law $q = \alpha n^2$. For lower values of q the slope becomes less. For values of q between 30 and 12, it is approximately 1·45. Experiments in the range $q < 12$ have not as yet been possible. Putting the law in the form $q = kn^p$, the experiments indicate a considerable diminution in the value of p over the range of observation. It is possible that with lower values of q, p may approach to unity, giving the linear recombination law proposed to explain the equilibrium of ionization in the atmosphere.

It is perhaps worthy of note that in the region where the law $q = \alpha n^2$ appears to hold, the calculated value of α is $1{\cdot}56 \times 10^{-6}$, which is closer to the values obtained by the earlier workers than to the more recent values such as that of Sayers[3].

University College, Dublin. June 3. P. J. NOLAN.

[1] Nolan, J. J., *Proc. Royal Irish Acad.*, **46**, 77 (1940).
[2] Power, A. D., *J. Frank. Inst.*, **96**, 327 (1923).
[3] Sayers, J., *Proc. Roy. Soc.*, A, **163**, 83 (1938).

Surface Films of Polar Crystals

THE study of atomic monolayers was initiated by Miss Pockels and the late Lord Rayleigh long ago, for capillary surfaces. It was capable of extension to electric crystalline structure, on the basis of the analysis of local polarization which is to be found in Maxwell's "Treatise" but is usually quoted under the names of Clausius and Lorentz. It compels the result that for a crystal polarized transverse to its surface a monolayer of compensating ions is required on its face, but in number *half* that in each ionic sheet of the crystal[1].

I have looked for a long time for some confirmation of so remarkable a result. The fundamental discovery of the diffraction of uniform pencils of electrons at the surface of a crystal, independently by Davisson and Germer in New York and by G. P. Thomson and A. Reid in Aberdeen, gave promise in this direction. This subject has now grown into an immense technical science with which only experts can be familiar, as is illustrated in the recent treatise by G. P. Thomson and W. Cochrane[2]. In turning over its pages I have hit upon the confirmation which I wanted, relating to the surface film, in a passage (p. 270) here reproduced, on the diffraction of pencils of slow electrons. It describes results reported in Davisson and Germer's early memoir.

"The new beams . . . thus possess the character of plane- rather than space-grating beams. Measurement shows, however, that the plane-grating spacing to which they correspond is in each case exactly twice that of the nickel atoms in the azimuth in question."

I have, however, not succeeded in explaining the concept of an index of refraction of the electrons along such lines.

Holywood, Northern Ireland. May 12. JOSEPH LARMOR.

[1] Cf. Larmor, "Mathematical and Physical Papers", 2, 620–29 (1928), "On Electro-crystalline Properties as conditioned by Atomic Lattices" reprinted from *Proc. Roy. Soc.*, A, **99** (1921), following on earlier discussions in *Phil. Trans.*, 2, 44–50 (1897).
[2] "Theory and Practice of Electron Diffraction" (Macmillan, 1939).

Flow Properties of Some Thermoplastics

Scott Blair and Coppen[1], dealing with the compression of cylinders under constant stress, have given a general method of specifying the rheological properties of plastic materials by making use of two characteristics ψ, k given by

$$\psi = s\sigma^{-1} t^k, \quad . \quad . \quad . \quad (1)$$

where s, σ, t have their usual meaning. Broome and Bilmes[2] have confirmed the validity of the treatment by their work on the stretching of asphalt strips.

Scott Blair[3] had previously suggested a modification of the Bingham-Murray equation for the emptying of an initially full capillary tube, instead of the usual filling of an empty one. For the case of materials not obeying Poiseuille's law, he suggested a parabolic plot of the data obtained. Fundamentally, as applied to the original Bingham-Murray method, this modification can be expressed by

$$\Psi = \frac{PR^2}{4} \cdot \frac{1}{h^2 - h_0{}^2}\, t^K, \quad . \quad . \quad (2)$$

where P is the pressure, R the radius of capillary, h the length of extrusion, t the time, and h_0 is the extrusion at time $t = 0$, and the exponent K "differs from unity to an extent which is the measure of the discrepancy from truly fluid behaviour". When $K = 1$, Ψ corresponds to a true viscosity. There is a formal similarity between equations (1) and (2).

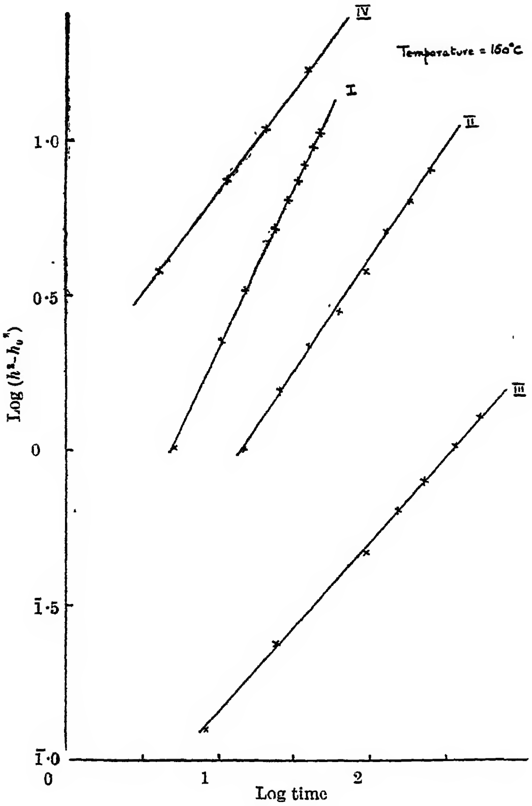
The value of the stress averaged across a diameter of the tube is $PR/4h$. From a comparison of the differential form of the Bingham-Murray equation

$$\frac{d}{dt}\left[\frac{2h}{R}\right] = \frac{1}{\eta}\,\frac{PR,}{4h} \quad . \quad . \quad . \quad (3)$$

with the equation defining the viscosity, η,

$$\frac{d\sigma}{dt} = \frac{1}{\eta}\, s, \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

we see that $2h/R$ can be regarded as the value of the strain averaged across a diameter. Using this ex-



	Thermoplastic	K	Ψ
I	Tenite I (M.S.)	1·0	$1{\cdot}17 \times 10^3$
II	Tenite II (M.)	0·74	$1{\cdot}35 \times 10^3$
III	Cellulose Acetate, low plasticizer content	0·57	$9{\cdot}55 \times 10^3$
IV	Polystyrene	0·54	$1{\cdot}60 \times 10^3$

pression for the strain, and defining Ψ by the equation

$$\Psi = s\left[\frac{d\sigma}{dtK}\right]^{-1}, \qquad . \quad . \quad . \quad . \qquad (5)$$

we obtain (2) by direct integration. Equation (5) is, in effect, the Scott Blair and Coppen equation (1) adapted to differential analysis.

For constant pressures we have found that plots of $\{\log(h^2-h_0^2), \log t\}$ give straight lines in the case of many thermoplastics, and thus reveal K.

Then

$$\log \Psi = \log \frac{PR^2}{4} + K - \log (h_{10}{}^2 - h_0{}^2)$$

where h_{10} is the extrusion after 10 seconds.

Since the average stress $PR/4h$ falls off as the flow proceeds, there is no suggestion that the conditions for a basic analysis of flow (that is, constant stress) are being satisfied. The above treatment, however, seems well suited to the specification of the flow properties of thermoplastics. Further investigation along these lines is in progress.

We have to thank the directors of the British Xylonite Co., Ltd., for permission to publish this note.

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Halex, Ltd.,
Hale End, E.4.

[1] Scott Blair, G. W., and Coppen, F. M., NATURE, 146, 840 (1940).
[2] Broome, D. C., and Bilmes, L., NATURE, 147, 176 (1941).
[3] "An Introduction to Industrial Rheology", p. 55.

'Shot Effect' in Temperature-Limited Diodes

THE 'shot effect' in temperature-limited (saturated) diodes has certain similarities with the 'Johnson effect' observed in electrical resistances. Though the classical formula of the shot effect may be derived in several different ways, to my knowledge it has not yet been done on the same lines as those used for obtaining a formula for the Johnson effect. J. Bernamont[1] has shown that the 'Johnson effect' formula, namely, $\bar{e}^2\nu = 4RkT$, may be obtained in the electronic theory of metals, using either the Lorentz or Sommerfeld theory of conductivity. The purpose of this note is to show that, following Bernamont's method for the Johnson effect, one may derive the classical formula of the shot effect.

Let $f(u)S.dx.du$ be the number of electrons in the volume element $S.dx$, dx being the length of the trajectory of an electron the velocity of which lies between u and $u + du$, and S the emitting area of the filament. Owing to the Maxwellian distribution of the electrons emitted by the filament, we have:

$$f(u)du = n2hme^{-hmu^2}du,$$

with $hmu_c{}^2 = 1$ and $1/2mu_c{}^2 = kT$, where T is the temperature of the filament. An electron of velocity u is equivalent to a current element the length of which is dx, and:

$$\delta j dx = u\varepsilon,$$

ε being the electron charge.

The mean square of the current is then:

$$\overline{j^2} = Sdx\int_0^\infty \frac{\varepsilon^2 u^2}{dx^2} f(u)du.$$

M. Courtines[2] has shown that the 'correlation function' of the current in a saturated diode is, where θ is the time of correlation,

$$\begin{cases} \overline{ii_t} = \dfrac{\theta - |t|}{\theta}\overline{j^2}, & \text{for } |t| \leq \theta \\ \overline{ii_t} = 0 & \text{for other values of } t. \end{cases}$$

The 'spectral component of intensity' of a function y, for 'infinitely brief' correlation, that is, for frequencies ν satisfying the relation $\nu << 1/\theta$ is[1]:

$$\overline{y_\nu{}^2} = 4\int_0^\infty \overline{yy_t}dt,$$

whence:

$$\overline{i_\nu{}^2} = 4S\varepsilon^2\int_0^\infty \frac{1}{dx}\cdot f(u)u^2du\int_0^\infty \frac{\theta-|t|}{\theta}\,dt,$$

and

$$\overline{i_\nu{}^2} = 2S\varepsilon^2\int_0^\infty \frac{\theta}{dx}\cdot f(u)u^2du.$$

Now:

$$\theta/dx = 1/u, \text{ and } \overline{i_\nu{}^2} = 2S\varepsilon^2\int_0^\infty f(u)udu;$$

so that

$$\overline{i_\nu{}^2} = 2S\varepsilon^2 n.$$

But

$j = S\varepsilon n$ is the mean diode current; hence finally:

$$\overline{i_\nu{}^2} = 2\varepsilon j.$$

M. SURDIN.
Repatriation Office,
37 Rua da Emenda,
Lisbon.
May 24.

[1] Bernamont, J., *Ann. Phys.*, 7, 71 (1937).
[2] Courtines, M., Congrès International d'Électricité, Paris, 1932.

PHYSICAL INTERPRETATION OF QUANTUM MECHANICS*

By PROF. P. A. M. DIRAC, F.R.S.

MODERN developments of atomic theory have required alterations in some of the most fundamental physical ideas. This has resulted in its being usually easier to discover the equations that describe some particular phenomenon than just how the equations are to be interpreted. The quantum mechanics of Heisenberg and Schrödinger was first worked out for a number of simple examples, from which a general mathematical scheme was constructed and afterwards people were led to the general physical principles governing the interpretation, such as the superposition of states and the indeterminacy principle. In this way a satisfactory non-relativistic quantum mechanics was established.

In extending the theory to make it relativistic, the developments needed in the mathematical scheme are easily worked out, but difficulties arise in the interpretation. If one keeps to the same basis of interpretation as in the non-relativistic theory, one finds that particles have states of negative kinetic energy as well as their usual states of positive energy, and, further, for particles the spin of which is an integral number of quanta, there is the added difficulty that states of negative energy occur with a negative probability.

* Substance of the Bakerian Lecture of the Royal Society, delivered on June 19.

With electrons the negative-probability difficulty does not arise, and one can get a sensible interpretation of the negative-energy states by assuming them to be nearly all occupied, and an unoccupied one to be a positron. This model, however, is excessively complicated to work with and one cannot get any results from it without making very crude approximations. The simple accurate calculations that one *can* make would apply to a world which is almost saturated with positrons, and it appears to be a better method of interpretation to make the general assumption that transition probabilities obtained from these calculations for this hypothetical world are the same as those for the actual world.

With photons one can get over the negative-energy difficulty by considering the states of positive and negative energy to be associated with the emission and absorption of a photon respectively, instead of, as previously, with the existence of a photon. The simplest way of developing the theory would make it apply to a hypothetical world in which the initial probability of certain states is negative, but transition probabilities calculated for this hypothetical world are found to be always positive, and it is again reasonable to assume that these transition probabilities are the same as those for the actual world.

OBSERVATIONS MADE AT THE ROYAL OBSERVATORY, GREENWICH

THE observations made during 1936 at the Royal Observatory, Greenwich, have just recently been made available*.

The work is divided into five sections, the first of which, Section A, Meridian Astronomy, contains three subdivisions. Under (1), Transit Circle, 1936, the observed right ascensions, declinations and diameters of the sun, moon and planets are given and compared with the corresponding results as given in the "Nautical Almanac." These tabular places are derived from the well-known tables of Newcomb, Brown and Hill. The mean monthly corrections to Newcomb's place of the sun as given in the "Nautical Almanac" are shown, and also the corrections in longitude and latitude to Brown's "Tables of the Moon". These are deduced from the observed corrections to the right ascension and declination, the mean correction to the former being $0 \cdot 15^s$, corresponding to $2 \cdot 2''$ in mean longitude. Under (2), Time Service, is included a brief description of the reversible Transit "B" which was remounted on January 24, 1935, its place having previously been taken by Transit "D" on April 7, 1933. Collimation is eliminated by reversing the instrument on all stars, and observations are carried up to approximately 20^s of the meridian. Eighteen contacts are observed in each position of the instrument, when possible, and each signal is read to $0 \cdot 01^s$. Table II gives details of observation of clock corrections, and comparisons of Clocks Shortt Nos. 3 and 11 appear in Table V. The Greenwich time determinations are regularly compared with those of other observatories by the reception of wireless signals and the results are given in Table VIII. Under (3), Variation of Latitude, it is pointed out that as the Cookson floating zenith telescope was moved in 1936 to the Christie enclosure and remounted, a new observing programme being introduced at the same time, the results for the latitude variation given by the instrument will not be published for some time. The values of the latitude variation taken from the results of the International Latitude Service are given, and these have been used in the Transit Circle reductions.

Section B, Equatorial Observations, contains the results of the observations of double stars made with the 28-inch refractor. The list deals with the first observations carried out on the programme drawn up in 1936; the pairs were selected from Aitken's "New General Catalogue of Double Stars." These pairs were chosen on the following grounds:

* Observations made at the Royal Observatory, Greenwich, in the Year 1936, in Astronomy, Magnetism and Meteorology, under the direction of Dr. H. Spencer Jones. Pp. viii+A78+B16+Cix+161+D66+E46+38. (London: H.M. Stationery Office, 1939.) 35s. net.

(1) rapidly moving pairs for which orbits have been computed or will be computed within a few decades; (2) pairs which, though not moving rapidly, nevertheless deserve an observation in the present decade, either because they are known to have a slow motion or because they may be neglected pairs.

Section C, Photoheliographic Observations, gives the positions and areas of sunspots and faculæ for each day in the year 1936. Photographs from three observatories were used. Those obtained at the Royal Observatory, Greenwich, were taken with the Dallemeyer photoheliograph of 4 in. aperture, usually stopped down to 2·9 in., and, in a few cases, with the Thompson photoheliograph of 9 in. aperture. The diameter of the sun's image at the secondary focus in both instruments is 7½ in. at the earth's mean distance. The photographs from the Cape Observatory were taken with a Dallmeyer photoheliograph giving an image of the sun about 7½ in. in diameter. Those obtained at Kodaikánal were taken with a Cooke photovisual object-glass of 6 in. aperture, the image of the sun being on nearly the same scale. This section also gives a general catalogue of groups of sunspots for 1936 and 'ledgers' of the areas and heliographic positions of groups of sunspots for 1936.

Sections D and E, Magnetic and Meteorological Observations, give a full description of the buildings and equipment of the magnetic station at Abinger and also of the results of the magnetic observations, followed by a corresponding description of the meteorological apparatus and the results of the observations.

CONCRETE IN SEA WATER

THE current issue of the *Dock and Harbour Authority* contains the reproduction from the *Proceedings of the American Society of Civil Engineers* of a paper by Homer M. Radley in which the author gave a statement of the conclusions he has reached as a result of extended observation of concrete marine structures along the Pacific coast of the United States and Canada. Contrary to the widely held view that decomposition of concrete in sea water must necessarily occur as a result of the chemical action of sulphate of magnesium, he states that, over a long period no evidence of any attack of this nature was found, and he holds that such deterioration as occurs is due to other causes.

Arguing from the characteristic form and manifestation of attack by magnesium sulphate as advanced by Vicat, he concludes that, if this occurred in the manner described, exposure to full sea-water action for a period of twelve or fifteen years should produce distinct evidence of porosity or disintegration. His investigation showed, on the contrary, that concretes made with many brands of Portland cement continue after fifteen or more years of service to exhibit the original wood-grain and other marks of the shuttering used in construction. He points to several other causes of disintegration and disruption —the rise and fall of the tides and the alternate wetting and drying of the concrete surface, mechanical blows and abrasion from flotsam and drift, and the action of storm waves and the grinding of the boulders which they toss about. Deficiencies in the quality and structure of the concrete are responsible for the most characteristic forms of deterioration, weak concrete being readily abraded, honeycombed areas becoming cavitated, laitance seams giving rise to extended voids and so on. In these respects he finds little to choose between fresh water and salt water, and contends that the same qualities which give resistance in the one are good in the other. Associated with salt water there is, however, the scaling and disruption which arise from the crystallization of salt in the exposed upper parts. These several aspects of deterioration are discussed in considerable detail, and many photographs illustrate the different types noted.

THE IMPERIAL CANCER RESEARCH FUND

BY DR. E. BOYLAND

THE thirty-eighth annual report of the Imperial Cancer Research Fund was presented to the general meeting of governors in April. New work on the nature and cause of cancer has been carried out in the Fund's laboratories at Mill Hill. In addition to this normal work, Miss Ida Mann and Dr. B. D. Pullinger have carried out experiments on the effect of ascorbic acid in mustard gas burns of the eye, and on other problems for the Ministry of Supply. Several members of the staff have been absent on war service and, although the volume of research is perhaps not so large as in normal years, work of interest and real value has been accomplished.

Histology is still an important and essential branch of cancer research. Without the microscope it would often be difficult or impossible to determine whether tumours were malignant or not. Dr. L. Foulds has written a critical review on the histology of tumours[1], a field in which workers in the Imperial Cancer Research Fund laboratories have made important contributions in the past.

Dr. B. D. Pullinger has extended her investigation on the specific response which is given by mouse skin to carcinogenic substances. With the carcinogenic 5:9:10-trimethyl-1:2-benzanthracene small amounts produce the response while larger amounts destroy the epithelium without producing the characteristic reactions. This result fits in with the finding of Prof. E. L. Kennaway and Prof. J. W. Cook that this substance is a more effective carcinogenic agent in dilute than in strong solutions.

Mr. H. G. Crabtree has continued his investigations

on biological effects of organic chlorine compounds. The effect of chlor compounds on the carcinogenic action of benzpyrene is rather complicated and varies with their concentration, type and time of application. Application of low concentrations of chloracetone alternately with benzpyrene to the skin of mice reduces the carcinogenic action, but if a higher concentration of chloracetone is applied after discontinuing the applications of benzpyrene, the carcinogenic action is enhanced. The effect of a series of chlor compounds can be correlated to some extent with their chemical and physical properties.

Tumours can be induced in animals either with biologically produced agents or with synthetic carcinogenic compounds. Some time ago Dr. R. J. Ludford described the transformation of normal chick fibroblasts into malignant cells induced by treating tissue cultures of fibroblasts with filtrates of fowl sarcomas. It has so far not been possible to produce an analogous change with carcinogenic compounds. Cultures of cells from pure-line mice were grown in the presence of methyl cholanthrene or 3:4-benzpyrene for times varying up to six months without producing malignant cells.

Dr. W. J. Purdy and Dr. R. J. Ludford have continued to investigate the factors present in birds with retrogressing filterable tumours. The blood of ducks in which the Fujinami tumour was retrogressing did not neutralize the corresponding virus, nor did it inhibit the growth of the tumour cells in tissue culture. Thus it has not been possible to determine the nature of circulating antitumour factors, if indeed such occur, when multiple tumours retrogress. It is probable that the action of the effect on tumours is indirect. Dr. R. J. Ludford has grown fragments of rat uterus and vagina in culture and treated the isolated tissues with œstradiol. Neither in these experiments nor in others, in which cultures of combs from chick embryos were grown in the presence of testosterone, did the hormones have any effect on growth. The hormones must therefore act indirectly.

The Fund has continued to co-operate with other laboratories and is still particularly helpful in maintaining and supplying many strains of transplantable animal tumours. During the past year the Fund has been fortunate in having received more than £17,000 in legacies; the whole of which has been added to the endowment fund.

[1] *Amer. J. Cancer*, **39**, 1 (1940).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN GEOGRAPHY at the Brighton Municipal Training College for Women—The Education Officer, 54 Old Steine, Brighton (July 12).

LECTURER IN MATHEMATICS and A WOMAN LECTURER IN GEOGRAPHY—The Principal, Derby Technical College, Normanton Road, Derby (July 12).

INSTRUCTOR IN WORKSHOP PRACTICE AND PROCESSES in the Schools of Technology, Art and Commerce (Engineering Department)—The Chief Education Officer, City Education Office, 77 George Street, Oxford (July 15).

PRINCIPAL of the Lancaster Storey Institute Technical College and Junior Technical School—The Director of Education, Education Offices, High Street House, Lancaster (July 19).

TEACHER OF ENGINEERING SUBJECTS—The Acting Principal, Technical Institute, Ashford, Kent.

LECTURER IN ENGINEERING for the Achimota College, Gold Coast—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9637).

ASSISTANT ENGINEER for the Malayan Government Public Works Service—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9306).

HEAD OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT of the Royal Technical College, Salford—The Director of Education, Education Office, Chapel Street, Salford, 3.

ASSISTANT ENGINEER in the Government of Zanzibar Public Works and Electricity Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9634).

MAINTENANCE ENGINEER in the Government of British Guiana Transport and Harbours Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9393).

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

Friday, July 18

INSTITUTE OF PHYSICS (MANCHESTER BRANCH) (in the Physics Department, University, Manchester), at 7 p.m.—Dr. H. Spencer Jones, F.R.S.: "Problems connected with the Construction of Large Telescopes, with special reference to the 200-inch Instrument".*

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1941, June 7. Pp. 16. (London: Royal Observatory, Greenwich.) [106

London Bird Report for 1940: Being an Annual Report on Bird-Life within Twenty Miles of St. Paul's Cathedral. Compiled by R. S. R. Fitter. Pp. 20. (London: London Natural History Society.) 1*s.* 6*d.* [126

University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1940. Pp. 150. (Bristol: The University.) [126

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 12: On *Salpingostoma dasu*, a New Carboniferous Seed from East Lothian. By Prof. W. T. Gordon. Pp. 427–464+6 plates. (Edinburgh and London: Oliver and Boyd.) 7*s.* [136

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1940, presented to the Annual Meeting, 10th March, 1941. Pp. 12. (York: Yorkshire Museum.) [136

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 25, 1940. Pp. 609. (London: Society of Chemical Industry.) 16*s.*; to Members, 7*s.* 6*d.* [166

Other Countries

India Meteorological Department. Scientific Notes, Vol. 8, No. 89: Synoptic and Aerological Study of a Thunderstorm-day at Agra, December 3rd, 1936. By S. Basu and Ram Sahay. Pp. 67–76+6 plates. (Delhi: Manager of Publications.) 1 rupee; 1*s.* 6*d.* [106

Annual Report of the United States Commissioner of Education for the Fiscal Year ended June 30, 1940. Pp. v+105. (Washington, D.C.: Government Printing Office.) 20 cents. [126

U.S. Treasury Department: Coast Guard. Bulletin No. 29: International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1939. Pp. v+133. (Washington, D.C.: Government Printing Office.) [126

U.S. Office of Education: Federal Security Agency. Bulletin, 1940, No. 7: Laws Affecting School Libraries. By Edith A. Lathrop and Ward W. Keesecker. Pp. viii+136. (Washington, D.C.: Government Printing Office.) 20 cents. [126

The Meteorology of Great Floods in the Eastern United States. By Charles F. Brooks and Alfred H. Thiessen. (From the Smithsonian Report for 1938.) (Publication 3506.) Pp. 325–348. (Washington, D.C.: Government Printing Office.) [126

Hurricanes into New England—Meteorology of the Storm of September 21, 1938. By Charles F. Brooks. (From the Smithsonian Report for 1939.) (Publication 3563.) Pp. 241–251. (Washington, D.C.: Government Printing Office.) [126

Records of the Geological Survey of India. Vol. 75, 1940, Professional Paper No. 8: Manganese-Ore in Bamra State. By Dr. M. S. Krishnan and Dr. P. K. Ghosh. Pp. 22+iv+3 plates. 14 annas; 1*s.* 3*d.* Vol. 75, 1940, Professional Paper No. 12: An Earthquake in the Great Pamir. By Dr. A. L. Coulson. Pp. 11+2 plates. 7 annas; 8*d.* (Calcutta: Geological Survey of India.) [166

U.S. Office of Education: Federal Security Agency. Bulletin, 1940, No. 5: Bibliography of Research Studies in Education, 1938–1939. By Ruth A. Gray. Pp. xiv+411. (Washington, D.C.: Government Printing Office.) 35 cents. [166

Bulletin of the American Museum of Natural History. Vol. 77, Art. 9: The Birds of Mt. Auyantepui, Venezuela. By E. Thomas Gilliard. Pp. 439–508. (New York: American Museum of Natural History.) [166

VOL. 148
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NATURE

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NATIONAL CHARACTER

EVERYDAY assertions of differences in character between one nation and another have for long been maintained in the face of scepticism, and the scepticism has often seemed the more scientific attitude. It is as easy to show confusions, contradictions and over-simplifications in the popular conceptions as it is difficult to find scientific proof of the real differences which, in a confused way, they may be registering. What then should be the role of a scientific treatment of the question? Scepticism is scarcely enough. Differences of national character (in some sense of the term) have certainly not been disproved. That they have also not been proved may well reflect on the crudity of the sociological and scientific techniques at our service. In these circumstances it would seem that a proper function of scientific discussion is that of sympathetically clarifying the popular conceptions and showing what, at their most plausible, they would be, and in what directions scientific proof or disproof could most profitably be sought.

Some such purpose informs an address on national character given by Prof. Morris Ginsberg at a recent meeting of the British Psychological Society. Prof. Ginsberg's caution and legitimate scepticism could scarcely be greater than they are. Yet his attitude towards the popular conceptions is sympathetic and constructive. At the present time such an approach is particularly welcome, attempting as it does a reconciliation between the standards of scientific thinking and the demand for positive contributions to an important topical question of wide interest.

Allowing fully for the effects of prejudice in observers and for the difficulties of defining both 'nation' and 'character', Prof. Ginsberg still thinks it a mistake to dismiss the idea of national character as a mere illusion. Instead, he asks in what direction there lies most hope of detecting and identifying differences in national character. With our present techniques for observing group behaviour he sees small likelihood of demonstrating by direct observation that particular traits of personality are more prevalent among one nation than another. The belief, for example, that the Germans are more docile than the English, or the French more articulate, cannot yet be scientifically

confirmed or disproved by the observation of individual behaviour. As a sociologist, Prof. Ginsberg puts more faith in analysing "the psychological basis of the collective achievements of peoples", their institutions and their corporate policies.

The pitfalls in the way of deducing national character from national institutions are not overlooked. In particular, allowance has to be made for the historical background of the institution (and often its geographical background) and for the class structure from which it emerged. This caution would be needed, for example, in estimating the significance for the English national character of our public schools, our non-conformist churches, our traditions of diplomacy. Prof. Ginsberg is of opinion that these and other similar difficulties can be sufficiently allowed for to permit of some valid deductions as to the national character implicit in collective achievements.

In illustration of this viewpoint he suggests that both the empiricism and the individualism which many observers regard as characteristically English can best be seen in our institutions. Individualism is evident "in the spirit of the English law which is a law of the liberty of the individual subject, in the strength of local government and resistance to centralisation, in the stress laid by Puritanism on the autonomy of the individual and in a very widespread and deeply rooted impatience of compulsion and restraint". An extreme form of individualism is also deeply rooted, according to widespread opinion, in the German character.

But there is an important difference between the two peoples in that among the English the individualism is counterpoised by a capacity for spontaneous organization, seen in the number of our voluntary societies, and in the history of the trade unions, the co-operative movement and the friendly societies. With this goes also the capacity for what Madariaga has called "collaboration in opposition", important no less in politics than sport. Among the Germans, on the other hand, individualism shows itself in politics as "a strong tendency to particularism and discord and an incapacity for wider unions except when they come under the influence of dominant leaders". Prof. Ginsberg inclines to the view that it is the Germans' lack of capacity for spontaneous organization which makes them seek unity through authoritarian discipline. "It is clear that, for whatever reasons, the need for authority is deeply rooted in German life and that the relationship of inferior and superior pervades all spheres of activity."

The English empirical tendency can be shown in our legislation and our politics, in both of which "there is a disinclination to formulate general principles, and piece-meal enactments are preferred". English international policy is especially tentative and piecemeal, its consistency over long periods being due to the constant influence of our geographical and economic situation and not to a formulated plan. The lack of deliberated, abstract planning in the growth of the British Empire contrasts with the French, and still more with the German, policy towards colonial possessions. A similar tendency is to be seen in English domestic politics and Church history: "in dealing with the practical problems of life the English mind prefers to proceed tentatively, by trial and error."

In contrast to the English tendency stands the German concern for system and generalization. The systematic regulation of practical public affairs, and painstaking and exact investigation in scientific work, form one aspect of the Germans' effort to maintain a balance against excessive individualism and vague emotionalism. In their intellectual life, however, there is a liking for abstract generalizations which "do not seem to be reached by analysis of sense experience but rather by a sweep of imagination or fantasy". Here their interest in system "is often not rooted in the need for order, not the product of a drive to classify and understand, but rather of an imaginative longing for grandiose architectural schemes".

It goes without saying that these views cannot claim the status of scientific conclusions. They reflect subjective impressions. But as distinct from impressions of transient everyday behaviour, observed under conditions which are seldom defined and never exactly repeatable, these views are interpretations of a body of permanent material —institutions, writings, historical policies—which remains available for further inspection and re-interpretation. No one, and certainly not Prof. Ginsberg, would deny that by the standards of experimental science we are here on most uncertain ground. Yet a consensus of the opinion of observers who differ in nationality but who are examining much the same data can claim a degree of probability which should ensure serious attention and provisional belief.

To explain differences in national character is even more hazardous than to identify them. The view that national character is based on the biologically inherited constitution of a people, the so-called racial theory, has in democratic countries received ample criticism. Prof. Ginsberg ignores, no doubt wisely, the complication which Jung's doctrine of the 'collective unconscious' has introduced into an already confused problem. But he effectively re-states the objections to the main theory. He insists, however, that we should not go to the other extreme of denying to biological

inheritance all significance as a factor in group character. "Unless we are prepared to deny the inheritance of mental characteristics we must regard it as highly probable that just as there are individual differences there are also group differences and that these play their part in shaping the collective life of groups. . . . The inherited constitution must in some sense put a limit to what can be achieved by social organisation." But Prof. Ginsberg has no hesitation in concluding that historical and social conditions play a much greater part than genetic factors in moulding national character. As he says, "it must be remembered that the range of human potentialities is extraordinarily wide and that upon the same hereditary elements very different social structures may be built. There seems no warrant for assuming any such differences between national groups as would amount to an inherited incapacity of any one for the arts and institutions achieved by another."

The immediate practical significance of this conclusion lies in the consequent recognition that national character is, for all its relative stability, capable of enormous changes. Those who might wish to make an end of the German nation on the grounds of its incorrigibility will find no support in Prof. Ginsberg's careful and comprehensive survey of the problem. He takes the view that even if there is "an inherited element in the character of nations of long standing they nevertheless retain considerable powers of adaptation and the limits of these powers cannot be determined with any accuracy from their previous history".

The means by which profound changes in national outlook and character may come about—such, for example, as the abandonment by the Germans of over-emphasis on authoritarian organization—deserve the fullest attention of social scientists. This question did not fall within Prof. Ginsberg's purview, but it is one on which both sociologists and social psychologists should have important matter to contribute. The former have evidence on the workings of the broader social institutions. The latter may be expected to throw light on the importance in this respect of the characteristic structure of the family in different nations. It is in the family that many of our most enduring social attitudes are learnt and certain fundamental social expectations formed. There can be little doubt that the intimate structure of the family, influenced as it always is by the position accorded to women in the world outside the family, is highly relevant to the emergence of a particular social outlook in adult life. Tempted to despair of a changed outlook in some nations, we have to remember that effective changes in such profound emotional dispositions must occur very largely in childhood—certainly with immense difficulty at any other period—and in the history of a nation like Germany there have not been many generations of children who have grown up during periods when the ideals of democratic co-operation had currency among the adult population.

The impossibility of scientific certainty in predicting the trends of development in national character is no good reason for abandoning all attempt at prediction. Where one observer goes completely astray, another, with greater insight and better opportunities of observation, will be far more dependable. At the present time it may well be that the practical judgment of men of affairs is as good a guide as any more scholarly or scientific assessment. In speaking of the Greeks, for example, Prof. Ginsberg thinks that their recent political and military behaviour "would have been predicted by no student of their character". Yet it is worth while to recall that Mr. Churchill (in "The World Crisis: the Aftermath") reports the belief of Mr. Lloyd George shortly after the War of 1914–18 that "The Greeks are the people of the future in the Eastern Mediterranean. . . . Their fighting power is grotesquely underrated by our generals. A greater Greece will be an invaluable advantage to the British Empire. The Greeks by tradition, inclination, and interest are friendly to us; . . . The Greeks have a strong sense of gratitude, and if we are the staunch friends of Greece at the period of her national expansion she will become one of the guarantees by which the intercommunications of the British Empire can be preserved. One day the mouse may gnaw the cords that bind the lion" (p. 391).

Some of the urgent, practical needs of warfare, notably the guidance of propaganda, demand the close study and collation of all that is known and alleged about the characters of the various nations. To a great extent such a study must be *ad hoc*, directed to answering limited questions of perhaps transient importance. For not only the relatively enduring character of a nation, but also its more transient moods and the particular aspects of character which are uppermost at the moment, are vitally important to the propagandist. To the statesman who must handle the broad issues of future policy the enduring features of national character and the trends of its development are equally significant. There can be few more important tasks for the social sciences than to contribute to a full understanding of the character, mood and prevailing interests of the nations among which the War is being fought, and by which an international order must be reconstituted, wherein all nations of the world may be able to advance along the road of civilization in peace and security.

THE BEHAVIOUR OF NATIONS

The Behaviour of Nations
An Essay in the Conduct of National Organisms in the Nutritional Field. By Morley Roberts. Pp. xi+180. (London: J. M. Dent and Sons, Ltd., 1941.) 12*s*. 6*d*. net.

THE author begins with an analogy that biological readers find difficult, namely, that between the State or nation and an organism. Its limitations concerning phases and duration of life, integration of component units, reproduction and external relations reduce its value. If, however, even a partial value be attached to the analogy, then the special parallel the author draws between the State and a low-grade organism becomes valuable, for there must be few who have not reflected that the greatest common measure of a large mass of humanity must be low; and Machiavelli has told us this for centuries in his own grim fashion.

Morley Roberts sets forth for us here in all its nakedness, gaunt and unashamed, the Machiavellian doctrine that society is based on force, that groups of mankind inevitably compete for nutrition—by which he means supplies of all kinds—that phases without war are but interludes, usually preparatory to another struggle. To him, leaders are chiefly those who perceive and express the movements of their time for new or increased supplies. He does not know what is meant by international morality, and decries the romantic conceptions of the Churches and other idealists. This is accordingly a book for idealists to read if they still feel disposed to indulge in that form of escapism which devotes itself to making paper plans for a better world.

In the world as it is, occupation without effective power of defence against organized mechanism is not real possession. Holland, Belgium, Norway, Poland, Yugoslavia, Greece, Italy, even France, were not really the possessors of their territories; they were temporary holders until such time as the great mechanism should descend upon them. Paper treaties professing to give security to the weak are frail; even worse, they are death-traps not seldom used by the great mechanism to gain time that it may do one job at a time, and that thoroughly.

Irritated national organisms which are equipped with mechanical power have not been amenable to moral reproof or to the diplomatic nursing that has come to be known as appeasement. Appease them by concession, and, at once, by the very principle of their being, they start scheming for more. Moral reproof, as in the pitiful case of Italy and Abyssinia in 1936, is equally futile, and still more irritating, a still greater excitant for the have-not organism which can obtain mechanical resources. Machiavelli told the Prince that he must either destroy or make a (subordinate) friend of his adversary; intermediate policies are disastrous.

Morley Roberts thinks history is largely a record of social pathology; even some of the more optimistic of us will go as far as to say it tells us, in the main, what comes of choosing the second, often even the third best.

The book is full of challenging opinions. Norway, Holland, Belgium, France were really destroyed before a gun was fired. Nationalism is a dream that is fading, and men in each nation can be found to co-operate with the enemy and to accept his crusade for a unified Europe, based on what the author calls the tribe, wherein are no differentiations, no parties, for parties would mean differentiation. The collapsed nation States of the west and north-west had advanced dangerously far beyond this tribal stage, and they acted as hypnotized rabbits facing a giant stoat. Nothing that has happened in the last three years but could have been foretold by any German boy of reasonable intelligence between Passau and Heligoland as the inevitable line of action of eighty million claustrophobes, lured, as ever, by the open sea and the sunny south, and pressed on by the spectre of the Slav birth-rate. Long-range politics are in large measure a function of the birth-rate. The author is fond of Spinoza's statement that he wished to understand rather than to abuse a thunderstorm, and the publisher refers to the book's passionless analyses; but, for all that, the fire burns fiercely under a biological cover.

There is another picture to be drawn. Units within which there is some legal restraint, some mutual aid, have grown from the days of hunter-collector groups through those of village cultivators and of rival city States to, and now just beyond, those of tribes and nations. What next? Are we to witness rival giant powers, Atlantic or Anglo-American, European or Germanic, Russian or 'Heartland', in the sense of Mackinder's remarkable forecast in "Democratic Ideals and Reality"; and Oriental? Or can we try, by reducing divergences of standards of living, to achieve a world order with a backing of adequate strength?

H. J. FLEURE.

SCIENCE OF DIETETICS

Hutchison's Food and the Principles of Dietetics
Revised by Prof. V. H. Mottram and Dr. George Graham. Ninth Edition. Pp. xxvii+648. (London: Edward Arnold and Co., 1940.) 21*s*. net.

I THINK some who read this book will have much the same thoughts that flash to mind when, after years, one meets an old friend of boyhood days. Pleasant memories of the past intermingle with instant impressions that his hair is greying and that he has acquired a 'middle-aged spread'.

I first met "Hutchison" nearly thirty years ago when he was a youngster of ten and showing vigorous and sturdy growth. He must have inspired many thousands as well as myself with his youthful enthusiasm for the science of food and nutrition. Then came maturity and well-earned distinction. Now, he is admittedly in early middle age and there appear to be signs that the prime of life is passed. It may be nothing more than a climacteric, because with the ninth edition, and the twenty-third printing "Hutchison" is in the course of becoming "Mottram and Graham". A transition of this character is always rather a critical period in the life of a standard text-book, which it may or may not successfully survive. Some years ago a group of Bayliss's friends—the reviewer was one of them—'revised' his famous book on "General Physiology". The motive was admirable because he was at that time too ill to undertake the revision himself, and his friends and colleagues were happy to show their deep affection for him by taking on a task which he had set his heart on completing. Well-meaning as were our efforts, they were, I think, a failure. The book lost almost all that had formerly reflected the personality of Bayliss himself. Sometimes there is more success, "Kirke" became "Halliburton", "Halliburton" became "McDowall" and, still, after getting on for a century, we have a widely read and 'standard' work.

I feel sure many thousands of "Hutchison's" old friends will sincerely hope that "Mottram and Graham" survive as fortunately, for there is certainly real need for a trustworthy text-book on this subject, particularly at the present time, when knowledge of the composition and function of foods is of such vital importance.

The reader will find in the first five chapters a good general account of current views on the part played by components of food. Of particularly topical interest is the discussion of protein requirements, a subject upon which experts are prone to differ in a rather alarming manner. Few of us realized, I think, how little definite was actually known about the protein requirements of adults until the exigencies of the War brought us face to face with the need for precise estimates. It is one thing for a committee of the League of Nations to sit around a table in peace-time and declare, quite arbitrarily it must be remembered, that 1 gm. per kilo of body weight is the desirable daily intake of protein for any ordinary man or woman. It is a very different story when an estimate is required of the least quantity of protein that must be provided to keep the population in good health under war, or even siege, conditions.

Uncertainty of a no less disturbing nature troubles us when we try to provide for the children, and one cannot but admit a feeling of humiliation when so great a volume of literature on protein reveals so little clean-cut information.

The chapter on vitamins is not the best in this section of the book. It is a little scrappy and could be greatly improved with small effort. For example, the references to the part played by vitamin D in calcification of bones and teeth is particularly disappointing. The reader might easily get a wrong impression from a statement such as that on p. 130 that the members of this group of vitamins act as catalysts at the site of calcification. There should have been a wider treatment of the influence of these vitamins on absorption of bone-forming elements, particularly phosphates, from the gut. Last, but by no means least, there is reference to Mellanby's "toxamin", which has been 'as dead as mutton' since the function of phytic acid in cereals was revealed.

The chapters on the composition of foods provide, as they have always done, a wealth of useful information. They would be even better if subjected to a little judicious pruning here and there, for one still comes across analyses and comments which seem to date from the 'good old days'.

This is a minor criticism but by no means an unimportant one. It may be illustrated by reference to the chapter on wines, which dates, all too obviously, from the days of Thudichum and Dupré's classic work, which, however dear to the heart of a wine-lover, is scarcely to be regarded to-day as a standard work on the composition of wines. The table of analyses on p. 457 is a museum

piece for a Victorian setting, but it strikes no note to-day, except one of sorrow for the passing of the lovely Château d'Issan, a victim of the tragic year 1932.

There are several useful chapters on practical dietetics in health and in sickness. They, too, need a little further careful pruning and grafting here and there to make them as good as one would wish, but they contain a great deal of valuable information. J. C. D

THE USES OF X-RAYS

Applied X-Rays

By Prof. George L. Clark. (International Series in Physics.) Third edition. Pp. xvii+674. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 42*s*.

It was the late Lord Rutherford who reminded us again and again that the advance of knowledge depends upon the development of technique. Alongside this, it is equally certain that the last decade or so has provided a continuous reciprocity between the fascinating task of finding new outlets for applied physics, and the urge to press on still further with instrumentation in order to attack new problems. Probably this dual process is nowhere better seen at work than in the field of X-rays. A bare half-century has in fact sufficed to bring us from that charmingly modest—almost detached—announcement by Roentgen at Würzburg to the present moment, when X-rays are nothing accounted of in everyday life.

A consequence of all this is that to appreciate what X-rays can do constitutes a minor research in itself, since their uses extend to almost every industry, and to medicine, biology and the arts. A case in point is that of non-destructive testing. To control at every step the fabrication of a product is often essential, but may be comparatively easy, since one is not confronted with the complexity and value of the finished article. Obviously, only very special physical methods can cope with this final stage, at which X-rays have proved their worth time and time again. Examples are the examination of golf-balls for correct core-centration, of shells and cartridges for proper filling, the counting of packed materials, including the possibility of locating 'foreign bodies', whether they got there by accident or by design.

Of more purely scientific interest has been the rapid advance in our quest for substances displaying exceptional properties, like the long-chain polymers, and synthetic materials in general. X-rays have been the means whereby the desired characteristics can be explored, and the edifice erected according to the laws of molecular architecture. Strength and resilience, plasticity and flow, are features which are not beyond us to produce at will. Moreover, when the work is done, it may well be a thing of beauty and a joy for ever.

In the third edition of his "Applied X-Rays", Prof. Clark provides a distinguished survey of the whole terrain of X-ray applications. He is careful to devote a considerable portion of his book to a detailed discussion of the tools at command—tubes and high-tension equipment—together with the amount of theory essential for the proper interpretation of results. This portion is decidedly well done; it avoids the common mistake of overloading the text with complexities far in excess of the needs of most readers. There is a somewhat large corpus of semi-classical subjects like X-ray and atomic spectra, which might perhaps have been more curtailed: t is a moot point how necessary these topics are in a volume dedicated essentially to applications.

It is likely that the chapter on radiography will give the reader the greatest satisfaction, for the reason that it brings together a host of matters rarely found in print together. In the section dealing with the arts, there are unfortunately a number of minor inaccuracies; an important point, however, which the author scarcely makes clear, is that the success—or otherwise—of a radiographic investigation of a painting depends largely upon the varying thicknesses of paint traversed, and not upon their chemical composition. Coal-tar pigments, naturally, do not occur in the Old Masters, and yet X-ray results have often proved extremely revealing in such cases. The reason lies in the fact that the visible paint layers are very thin.

A most intriguing subject is that of micro-radiography, in which a small exposed spot is magnified about a hundred times microscopically, or by projection. A plate of illustrations shows the capabilities of the method.

Prof. Clark has produced an admirable guide to the applications of X-rays; his volume is expensive, but there is nothing quite like it in Great Britain. It can be sure of a welcome.

F. IAN G. RAWLINS.

STEREOGRAPHIC PROJECTION

The Stereographic Projection
By F. W. Sohon. Pp. ix+210. (Brooklyn, N.Y.: The Chemical Publishing Co., Inc., 1941.) 4 dollars.

F. W. SOHON, S.J., director of the Seismological Observatory of Georgetown University, has written a very valuable book. This is a method of representing a solid body (usually figures on the surface of a sphere) on a plane, the centre of projection being a point on the surface of a sphere, and the whole sphere being represented once on an infinite plane. The projection has the merit that circles are represented as circles and that angles are retained. The book was not intended by the author to be exhaustive, but it contains a good selection of proofs, some by vector methods, and explicit applications to many problems including some in astronomy, hydrodynamics and seismology.

The seismological problem discussed by Sohon is the determination of the epicentre of an earthquake from a knowledge of its great circle distances from several seismograph stations by the semi-tangent method using geocentric latitudes (compression $\frac{1}{297}$). The degree of accuracy of this method will naturally depend on the accuracy of the seismograph timing, the accuracy of the travel-time tables for the two pulses recognized, and the degree to which the depth of focus may be allowed for in computing the great circle distances.

The book is recommended to students and research workers in mathematics (especially geometry, differential geometry, complex variable and hydrodynamics), cartography, astronomy, seismology and crystallography. It is handy in form, well arranged, printed and produced, contains tables including stereographic projection elements for all seismograph stations computed by Weston-Woodstock students, and there is an adequate index. E. T.

POWER PLANT FOR AIRCRAFT

Aircraft Engines
By A. W. Judge. Vol. 2. Pp. vii+446+93 plates. (London: Chapman and Hall, Ltd., 1941.) 30*s*. net.

THIS is the second volume of what is intended to be a comprehensive treatise on aircraft engines and accessories. The first volume, reviewed in NATURE of February 8 (p. 158), dealt largely with the factors which influence the performance of the engine under varying conditions of operation, but included also descriptive matter relating to carburetters, superchargers and cooling devices. The present volume deals mainly with engine types, details of construction, the remaining accessories, operation and testing.

Steady and rapid improvements in specific output and economy have taken place in recent years, largely due to supercharging, higher compression ratios, the use of light alloys and of high-tension steels. In the twelve years prior to 1940, speed has increased from 1,800 to 2,800 r.p.m., and piston speeds of more than 2,500 ft. per min. are now normal practice. Brake mean effective pressures have also increased from 125 to 220 lb. per sq. in. and more, so that the b.h.p. obtainable from a given cylinder capacity has increased by 150 per cent in this period. There is little doubt that these figures are conservative in relation to still more recent developments, and the author quotes brake mean effective pressures of more than 300 lb. per sq. in. at 2,400 r.p.m. which have been obtained from engines operated by sleeve valves.

In making comparisons between different types of engines, there are a number of important factors to be considered. These include power plant drag, moments of inertia of the engine about axes perpendicular to the axis of rotation, vulnerability to attack in the case of military aircraft, specific fuel consumption, specific weight, reliability under operation at full power for lengthy periods, accessibility for overhauls and adjustments, possible obstruction of view of pilot, convenience of attachment to fuselage, variations of torque reaction, cooling arrangements and silencing. The degree of complication involved will also influence the cost of manufacture and rate of output, in addition to increasing the necessary stock of spare parts. The relative importance of the different items will, of course, depend upon the nature of the duty for which the engine is designed, and this accounts to a large extent for the variations in size and type of the engines in actual use.

The author of the volume under review has borne all of these factors in mind and has presented a considerable amount of information which is not easily available in other than scattered publications, a list of which is given in an appendix, and gives a clearer picture of modern developments, accompanied by diagrams and illustrations which are really informative. Search for information on a particular type of engine or accessory, which is facilitated by an excellent index, seldom fails to supply the required data in a concise but intelligible and useful form.

The development, present position and future possibilities of the compression-ignition engine, both two-stroke and four-stroke, are given adequate discussion and accompanied by descriptions of recent types. There are undoubted possibilities in compression-ignition engines for long-distance flights, particularly where flights at high altitudes are concerned, and in some respects the design problems are simpler than is the case with road vehicles operating at widely varying loads and speeds, so that the information and data given by the author will be welcomed.

Components, lubricating systems, the ignition system and exhaust systems all receive concise but adequate treatment, and in no case does the author descend to mere catalogue particulars.

There are very few misprints, and these are fairly obvious. On p. 225 the author refers twice to the 'Mitchell' thrust bearing, on p. 324 a plug gap of 0·24 in. is mentioned and on p. 372 the Kadenacy effect is referred to as an exhaust pipe effect, which is, of course, not the case.

The publishers have studied the convenience of users by the adoption of a flexible type of binding which permits of the book being left open at any desired page, by the clear reproduction of the numerous diagrams and half-tone illustrations, and the clearness of the type used.

Generally the second volume maintains the high standard of the first volume, and is a very useful and up-to-date contribution to the study of aircraft engines. A. T. J. K.

ELECTROCHEMISTRY IN THE UNITED STATES

Industrial Electrochemistry
By Dr. C. L. Mantell. (Chemical Engineering Series.) Second edition. Pp. x+656. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 38s.

THE first edition of Dr. Mantell's valuable work has been thoroughly revised and brought up to date, and has grown by some 130 pages in the process. The text has been rewritten almost entirely, so much so that it may be asked whether the author has not taken unnecessary trouble in this respect, since quite large portions of the present version are mere paraphrases of the original.

A feature of the book which cannot fail to strike an English reader is that it appears to indicate the United States as the source of nearly every electrochemical discovery and development subsequent to those of the early pioneers. While admitting the great progress made in the United States and the magnitude of its electrochemical industries, it is to be hoped that the importance of maintaining the international character of the best scientific works is not being forgotten. Such a state of affairs has prevailed for some time in certain parts of Europe, where it is probably due to a deliberate national policy. No such accusation is made against the author of the present work, for it is clear that the fault, if such it can be called, is not easily avoidable. The best chapters are evidently compiled from data supplied by men with a thorough practical knowledge of their subject, and it is to this fact that they owe their excellence. Any attempt to apply the same procedure for foreign countries must necessarily be very difficult and, in present circumstances, almost impossible. Rather than present second-rate material, the author has decided to confine his attention to a high-grade, but somewhat restricted, source of supply.

It is suggested that the difficulty might be met in a future edition by largely increasing the number of references to foreign literature and by adding a few more descriptions of European plant when obtainable. Space for this could be saved by omitting much of the theoretical matter, which may be found in any text-book on physical chemistry, the chapter on electronics and most of the appendix; surely a table giving the pounds of xenon deposited by 1,000 ampere hours is not of much practical importance.

Leaving the question of nationalism, which is perhaps a side issue, full support may be given to the author's contention that electrochemical engineering should be regarded as a branch of chemical engineering. Chemical engineering involves not merely a description of plant, but also its efficient operation, and for this purpose data are required. The chapters on electro-plating, electro-refining and electro-winning, which have

been expanded very considerably and, as already mentioned, bear the impress of the expert, are of particular value in this respect. They illustrate also the importance in commercial practice of small traces of impurities and the careful control of conditions, factors which are sometimes neglected by the inexperienced.

The short chapter on power generation and economics, while admirable for its conciseness, might be further expanded with advantage, and the same applies to materials of construction for electrochemical apparatus, which, considering their importance, are treated with undesirable brevity. On the other hand, the first part of the chapter on electrical discharge in gases seems somewhat out of place.

The whole work is profusely illustrated with flow sheets, diagrams and drawings of plant, while the text is clear, carefully arranged and with no suspicion of dullness. In short, this member of the Chemical Engineering Series is fully up to the high standard of its predecessors and in some respects is in advance.

H. E. WATSON.

REPTILES OF CEYLON

The Tetrapod Reptiles of Ceylon
Vol. 1: Testudinates and Crocodilians. By P. E. P. Deraniyagala. (Colombo Museum Natural History Series.) Pp. xxxii + 412 + 24 plates. (Colombo: Colombo Museum; London: Dulau and Co., Ltd., 1939.) 10 rupees; 15*s*.

MUSEUMS of natural history exist in order that they may make collections, and by the development of systematic zoology and botany, and of similar aspects of mineralogy and geology, so organize them that they are available to scientific workers. Their own publications have therefore been concerned primarily with taxonomy, taking the form of systematic catalogues. But recently, when old-fashioned 'systematics' have reached a point at which further exploitation has given diminishing returns, the interest of museum staffs has spread into wider fields, and such portents as the establishment of a department of experimental zoology, with an exceptionally well-equipped laboratory, by the American Museum of Natural History, have made their appearance.

Thus the publication by the Colombo Museum of a "Monograph of the Tetrapod Reptiles of Ceylon", which in 412 pages discusses only ten species of Chelonia and Crocodilia, is less surprising than it would have been ten or twenty years ago.

In this most interesting work, the author, Mr. P. E. P. Deraniyagala, gives very full and excellent taxonomic descriptions of these species, which are founded on abundant materials and include valuable quantitative accounts of the range of variation within each species. But he adds to this expected information an immense mass of 'natural history'. His own work in the field and the laboratory, combined with facts drawn from the experiences of commercial fishermen and country dwellers, has enabled him to record the life-history of these reptiles, their nesting habits, the time of incubation, the behaviour of the young, their rate of growth, the feeding habits of the adult and indeed to enable us to see them as living animals pursuing their daily lives in the seas and lands of Ceylon.

Such information has very seldom been brought together in a collected form, and is most useful to anyone who, as a palæontologist or otherwise, has to consider the possible habits of animals, so far as they may be deduced from their structures.

In addition to this mass of new knowledge, the author gives us more. He has fetched into the laboratory, or rather into the garden, the eggs of some of these reptiles and has followed the course of the development of their external features in stages of a known age of incubation. The most important and interesting form with which he has worked is Dermochelys, the leathery turtle, an animal which differs so much from all other living Chelonia in the structure of its shell that it has necessarily taken a leading place in all discussions of Chelonian phylogeny. Mr. Deraniyagala not only collected the eggs of this animal and hatched them artificially, but also was able to rear the young, and indeed keep an individual until it was accidentally killed when nearly two years old. He has thus been enabled to give much new and most interesting information about the whole course of development, including that of the shell.

The monograph includes similar, though usually less complete accounts of the development of other forms, and for many of them gives an account of the development of the bones of the head, especially of those relatively late stages which have so seldom been considered, but which often present facts of much interest.

The whole is richly illustrated by the author's own often very vivid drawings and by photographs, and reflects great credit, not only on the author, but also on the Museum of which he is the director.

D. M. S. WATSON.

THE ORIGIN OF LIFE*

BY DR. C. F. A. PANTIN, F.R.S.
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UNTIL one hundred years ago the origin of living organisms was not a major problem in biology. Apart from the biblical creation, the view was frequently held that many at least of the simpler organisms were produced by spontaneous generation. The ease with which this idea was accepted was partly due to imperfect observation and partly to the view that there was a completely graded sequence between the living and the non-living. This found its most complete expression in the detailed 'scale of beings' of the eighteenth century. The disproof of individual cases of abiogenesis did not change this attitude until Pasteur showed that every supposed case of spontaneous generation was, in fact, due to infection by living organisms.

Pasteur's work raised the question of how the first organisms came into being. The publication of the "Origin of Species" made this one of the fundamental questions of biology. It is certain that at one time life, as we know it, could not have existed on earth. It must, therefore, either have arisen spontaneously from lifeless matter or have been conveyed to the earth from elsewhere after it had become inhabitable. The theory that life originated by infection from without has been discussed by Arrhenius and others. Bacterial spores may be conveyed to outer space by being carried to the upper atmosphere and then repelled from the earth by virtue of their electrical charge. Arrhenius showed that light pressure could then distribute such spores throughout the universe at an astonishingly high speed. In this way it would be possible to spread life from planet to planet. But apart from the fact that this hypothesis only shelves the question of how life began, it is rendered impossible by the physical conditions to which any living organism must be exposed in outer space. Spores might survive intense cold or a fair degree of heat. But they could not withstand the intense short-wave radiation from which we are shielded by the oxygen of our atmosphere. A minute spore can have no protection against this radiation, for the individual molecules of which it is composed will be destroyed.

We are thus forced to suppose that life began on this earth, and Pasteur's experiments must be taken to mean that life can only begin under very special conditions and that such special conditions must be sought for in the geological past. We can therefore ask three questions: What were the first organisms like? When did they arise? Under what conditions did they arise?

Evolution has carried life from simple to more complex organisms. Side by side with the complex existing organisms we find others which are far simpler. It was supposed that among these we might find more or less unchanged survivals of the primitive living organisms of an earlier age. There is much to be said for this view, though it involves a very important assumption. Evolutionary trees were made and still are made which are based upon it. Haeckel constructed a phylogeny based on existing organisms. An amœba was not only an existing organism, but its grade of organization also corresponded to that of an actual ancestor. More primitive than amœba was Haeckel's 'monera', structureless protoplasm supposedly without a nucleus. Existing monera disappeared in the light of investigation, but the idea of a 'primordial slime' remained.

'Primordial slime' was an invention of zoologists. It was, therefore, an animal. But animals require food, and their normal food can be traced to plants. Ray Lankester tried to evade this difficulty by supposing that original organisms "fed upon the antecedent products of its own evolution". One must, however, explain the presence of 'albuminoids' in a suitable form for animal consumption, and also how the animals obtained oxygen for respiration. There is good reason for supposing that all our oxygen was produced by plants; and the physical and chemical requirements of plants for growth are far simpler than those of animals. Church supposed that the first organism was a planktonic flagellate producing its substance by photosynthesis.

It is difficult to suppose that an organism so complex as a flagellate could arise by the spontaneous aggregation of its parts from non-living material. Even the smallest flagellate must contain about 10^{10} organic molecules. But is the aggregation of matter into a simple organism so improbable as it seems? May their morphological complexity be a natural property like the complexity of crystal structures? Leduc reproduced some of the obvious features of living organisms by inorganic models such as osmotic growths in silicate solutions. But the correspondence between these models and living organisms was very incomplete, and unquestionably the structure of a flagellate is

* Substance of a lecture delivered at the Royal Institution on May 27.

far too complex for us to suppose that it has arisen spontaneously. Nor is there any need for us to suppose this, because there exist much simpler organisms than flagellates.

The smallest known living organisms are the bacteria. These grade into the yet smaller viruses. It is a question of definition whether the latter are considered as living or not. Bacteria are of far simpler organization than flagellates. They are still, however, sufficiently complex to make it difficult to suppose that any bacterium could ever have come into being by the chance aggregation of material. They are saprophytes and require complex organic media which they make use of in very varied ways. Many are anærobic. In the viruses we have still smaller units than bacteria. Their properties as infective agents resemble those of pathogenic bacteria. They possess properties which are associated both with living and non-living systems. Their power of growth and reproduction is a characteristic feature of living organisms. At the same time their extremely small size overlaps the size of large molecules, and they have been obtained in the crystalline state. It seems scarcely possible to make this property agree with our normal ideas of the structure of living matter. Instead of a complex arrangement of different kinds of molecules on a small scale, it seems that some viruses simply consist of nucleo-protein molecules. Whether the virus particle is living or not, it is always associated with living tissue, though we may yet find a non-living medium suited to its requirements.

Our search for the simplest type of existing organism leads us into a rather curious position. We can find bacteria of smaller and smaller size, and still smaller things, the viruses. Whatever view is taken of the nature of the virus, it certainly makes conceivable the existence of living material on an almost molecular scale. From the point of view of finding the simplest organism, this is certainly a great step forward. But from the point of view of conceiving of the first living organism, what has been 'gained on the swings seems to have been lost on the roundabouts'. Compared with plants the chemical environment required by bacteria is very complex and varied. It may even require the absence of oxygen. Viruses even seem to require living tissue itself for their existence. While it is easier to suppose that these minute forms might arise spontaneously, we can only suppose their existence in an environment which is very different from, and much more complicated than, that which exists to-day. The origin of a suitable environment becomes as much a problem as the origin of the organism.

When and under what conditions did life arise ? It is still one of the remarkable facts of palæontology that the fossil record suddenly fails below the beginning of Cambrian times. Unequivocal remains of Pre-Cambrian organisms are few, and none are easy to interpret. Yet the abundant fauna of the Cambrian itself already shows all the main groups of animals, so that there must have been a long period of evolution before this time. Though poor in fossils, Pre-Cambrian rocks offer important information. The oldest rocks dated by radioactive methods are some 1,700 million years old. Before that there is evidence of sedimentary rocks which it has been suggested carry us back to 2,000 million years. Radioactive study of the age of meteorites leads us to conclude that the age of the solar system is not greater than 2,800 million years. Estimates by other methods agree with this. We can therefore examine rocks which cover a substantial portion of the earth history. The occurrence of graphite in the Pre-Cambrian is of particular interest because it suggests the early existence of organic matter and possibly of life. Most of the evidence of the earliest rocks suggests that conditions on the Earth's surface did not differ substantially from those of the present day. The existence of very old sedimentary rocks indicates the existence of exposed land and familiar weather conditions. There is some reason for supposing that the sea has not altered fundamentally in its composition since very early times. The Earth probably only took a matter of thousands of years to cool to approximately its present temperature ; and there appear to have been Pre-Cambrian ice-ages. Whatever factors control the temperature on the earth, they appear to have operated for a very long time.

There is, however, evidence of one important change in the course of Pre-Cambrian times. These ancient rocks have been exposed to great changes, but there is some reason for supposing that before the middle Pre-Cambrian iron was laid down in them in the ferrous form, and not until after this time was it laid down in the fully oxidized ferric form. This is important because it suggests a lack of oxygen in lower Pre-Cambrian times. The idea that the early atmosphere lacked oxygen is an old one. The present oxygen content of the atmosphere certainly depends on plants. Photosynthesis by marine planktonic diatoms alone produces oxygen at a rate which would regenerate the whole oxygen of the air in about 100,000 years—a geologically negligible period. Photosynthesis by plants may have become an important factor in middle Pre-Cambrian times. Before that an atmosphere of carbon dioxide such as that which occurs upon Venus probably predominated on the earth. The geological record thus suggests the existence of organic matter at a

very early period, under physical conditions not wholly different from those of the present day, except that there may have been a change from anærobic to aerobic conditions during the Pre-Cambrian.

The early presence of an anærobic organic medium finds support from another quarter. We know now that the larger planets have developed enormous atmospheres of hydrocarbons and ammonia from the solar material of which they are composed. The overwhelming reducing character of this material thus leads to the development on a planet of an anærobic organic medium. In a planet such as Venus, there has been further atmospheric evolution through the inability of the gravitational field to retain hydrogen, so that carbon dioxide has been produced. Venus and the Earth are very close in size. A similar condition must once have prevailed on the Earth, and would rapidly do so again if photosynthesis ceased. The reducing character of planetary material leaves no place for free oxygen except through the intervention of photosynthesis or some analogous process.

We do not know how complex would be the organic molecules formed in the original medium. Molecules of kinds utilizable by bacteria would fairly certainly be produced. We have seen that still simpler organisms require a still more complex organic environment, the nature of which we do not yet know. It helps us little to point out in our ignorance that an original planetary organic medium might develop the required environment. But one thing seems certain, an organic environment developed in physical equilibrium on a planet could not of itself develop living organisms. For one of the characteristics of life is that its existence requires a supply of energy, either as radiation or as substances at a higher chemical potential than their surroundings. A system in equilibrium cannot provide this; but solar radiation might have done so, at least before the atmosphere developed oxygen and absorbed its most active components.

The answer to the question "How did life originate?" thus seems to depend on the question "What are the environmental requirements of simple bodies such as the viruses, and could these requirements have been met in the original organic environment?" The answer to these questions will carry with it the answer to many other fundamental questions in biology.

THE SEARCH FOR ECONOMIC PLANTS*

By ARTHUR W. HILL, K.C.M.G., F.R.S.

DIRECTOR, ROYAL BOTANIC GARDENS, KEW

THE history of the spice plants has been dealt with at some length since they have played so important a part in geographical discovery, territorial acquisitions, and wars between European nations. There are however several plants of great economic importance which have travelled far from their lands of origin, of the wanderings of which we have no certain records. Among these are the coco-nut, sugar cane, banana, cassava, ground nut, and possibly the West African oil palm.

The coco-nut has no doubt been transported partly by ocean currents and partly by natives voyaging from island to island in the remote past when they took the nuts with them for food and planted them in the islands or coastal regions to which they migrated. Of ocean transport we have recent evidence in the germination of coconuts washed up on Anak Krakatau IV in 1932. The original home of the coco-nut seems definitely to have been the East Indian Islands, whence it has travelled to the West Indies and to America.

* *Continued from p.* 16.

Sugar cane, also East Indian, must have been similarly conveyed by natives for food on their voyages and then planted by the settlers in their new homes. In this way it has been distributed throughout the tropics before the existence of historical records. The edible banana, probably native in Thailand and Malaya, must also have been transported in much the same way.

Both the ground nut (*Arachis hypogea*) and the oil palm (*Elœis guineensis*) afford puzzling problems. The ground nut is now the staple product of The Gambia, but all its near allies are natives of Brazil and there is none in Africa. Similarly, the closely related species of Elœis occur in Brazil, but there is an allied species in Madagascar. It is an open question whether either economic plant is truly native in West Africa; if not, then it seems probable that natives voyaging from Brazil to West Africa may have brought over both the ground nut and oil palm, and also the American cassava (*Manihot utilissima*), as food in their

vessels, and so they became established on the west coast of Africa.

The cashew nut (*Anacardium occidentale*), much used in confectionery and like salted almonds and pine kernels on our dinner tables, which is a native of tropical South America, was introduced into South India in early days probably by the Portuguese. South India now supplies the major part of the world demand, and particularly the large markets of the United States of America. Nearly all the nuts imported to Great Britain and to the United States come from the south-west coast of India. Cheapness in the preparation of the product is the main reason for this somewhat anomalous condition of affairs.

Two misconceptions as to the original homes of economic plants may be mentioned here. First, the Jerusalem artichoke had nothing to do with the Holy Land—the name Jerusalem probably being a corruption of Terneusen in Holland, as Sir David Prain has ingeniously suggested, where tubers were first landed when they were brought over from America. Nor were either the New World pine-apple or prickly pear to be found in the Garden of Eden as figured by Parkinson on the title-page of his "Paradisus".

Coming to more recent times, one is reminded of the attempt by Captain Bligh in the ill-fated voyage of the *Bounty* to introduce the bread fruit (Artocarpus) from Tahiti to the West Indies, and of the success of his efforts on his second voyage, and of the introductions of economic plants and also, alas, of weeds to Australia and New Zealand as impurities in the seeds of the imported crop plants.

A brief reference must be made to the introduction of Cinchona and Para rubber from South America to Kew, and thence to India, Jamaica, Ceylon and Malaya, in 1861 and 1876 respectively. Flourishing plantations of Cinchona exist in the Nilghiri Hills and at Mungpoo and Munsong near Darjeeling, but those in Jamaica have not been maintained. Attempts are now being made to extend the cultivation in East Africa and also in Panama and Porto Rico. Java, however, is the chief source of the drug, mainly because the climate of the island is particularly favourable for the cultivation of the species which yield the greatest amount of quinine. Java, unlike India, has two rainy seasons, the south-west and north-east monsoons, which produce conditions very like those which occur in the Andes. The soil also is very favourable, but Java's success with *Cinchona Calisaya* types is mainly due to climate. Java has also been fortunate in obtaining seed of a high-yielding form of *C. Calisaya*—*C. Ledgeriana*—which has flourished under Javan conditions.

After the stocks of *C. succirubra* and *C. Calisaya* had reached India, Mr. Charles Ledger, who had obtained seed of a high-yielding form of *C. Calisaya* collected near Pelechuco, to the east of Lake Titicaca, offered this seed to the superintendent of the Government Cinchona Plantations at Ootacamund, who rejected it. He then offered it to the Dutch, who had been experimenting, somewhat unsuccessfully, with Cinchona in Java. The Dutch bought the seed, and so came about the flourishing industry in the island.

One of the assistants in the Nilghiris, however, a gardener from Kew, extracted some of Ledger's seed, and sowed half of it in the Nilghiris and sent the other half to Mungpoo. When the superintendent saw the seedlings and learnt their origin he had them all thrown away. Those at Mungpoo, however, were under the care of Mr. Gammie, who appreciated their value and kept them; they proved to be as valuable as had been stated by Ledger. This form and other good-yielding strains of *C. Calisaya* are still in cultivation at Mungpoo and Munsong. In any event, as it has since been found, *C. Calisaya* and its forms do not succeed under the conditions in the Nilghiris, nor do they thrive quite as well in northern India as they do in the better climatic conditions of Java.

More recently Kew has taken an active part in the growing and distribution of species of Hydnocarpus (Flacourtiaceæ), native in Burma, Indo-China and the East Indies, the seeds of which yield chaulmoogra oil, a specific for leprosy. With regard to this product it is interesting to mention that the resident physician of an asylum at Bangkok was treating the lepers there and trying to get chaulmoogra oil for the purpose when a botanist visiting the hospital was able to point out that supplies were close at hand: a tree was actually growing in the hospital compound, and it grows plentifully in Thailand.

Seeds of Aleurites (Euphorbiaceæ), the source of the Chinese tung oil, a high-class drying oil used for paint and varnish, have also recently been distributed by Kew to suitable parts of the Empire.

The recent widespread introduction of plants of economic importance to the tropical possessions of Great Britain and other countries has opened up political, as well as botanical, problems of considerable difficulty.

The growing of the West African oil palm in the Dutch East Indies, where they have been fortunate in establishing a pure-breeding type of good quality oil palm, is a case in point which may set up a state of economic warfare, as also the establishment of the clove industry in Madagascar and cocoa in West Africa versus Trinidad. The effect of the sugar beet subsidy on sugar-cane

cultivation in the West Indies, the competition of sisal in East Africa with the native product from Mexico, and the plantations of uniform varieties of New Zealand flax in the Argentine afford further examples where economic botany and policy may conflict.

Then again, the ease of transport and the cultivation of economic plants under plantation conditions disclose serious botanical problems. Not only may insidious diseases be easily transported by air, but also large areas of crops grown under plantation conditions afford a very ready means for the spread of any insect or fungus disease. Among the diseases which now threaten important economic products may be mentioned the Panama and the leaf spot diseases of bananas, Cacao witchbroom of cocoa, mosaic of cassava and other economic crops, wither tip of limes and cloves in particular. Such maladies necessitate researches in order to try to produce forms and varieties which may be immune to the diseases, and research in this direction is being undertaken especially by the Imperial College of Tropical Agriculture in Trinidad (see NATURE, March 8, p. 282; March 15, p. 313; March 22, p. 344; March 29, p. 380) and the East African Research Station, Amani, as well as by specialist officers in the Departments of Agriculture in the Dominions, Colonies, and in India. Attempts are also being made to discover higher-yielding forms of such economic plants as sugar cane, rice, para rubber and cacao, by cross-breeding and selection, and when found, propagating them by budding and grafting, cuttings or seed.

With regard to bananas, research is being undertaken to find wild types of Musa in the original home of the edible banana, in the hope of finding types immune to Panama disease, which can be used for cross-fertilizing with cultivated forms; similar work is also being undertaken in Trinidad with regard to Cacao. As we have recently found at Kew that young shoots of Cacao strike fairly rapidly, it will be possible to take cuttings from pure races of high-yielding plants, and so save the labour of budding and grafting.

Other economic plants which are receiving the attention of Kew at the present time for the benefit of our tropical possessions include passion fruit, papaw, cassava, Ephedra, Derris and tuba root or barbasco. The first three mentioned are affected by virus diseases and various types have been sent out to Amani in order that forms resistant to the virus disease may be raised in East Africa. Ephedra, Derris and tuba root yield important insecticides, and attempts are being made to cultivate plants yielding the highest quantity of rotenone, which is very variable in different strains and species. Stocks obtained at Kew have been sent to the West Indies in the hope that a profitable industry may be established to meet the demand.

It may be useful to summarize, in conclusion, some of the more important economic plants which now form the principal industries of the countries to which they have been introduced.

Cacao, which is native of South and Central America, has been introduced to Trinidad and other West Indian islands and has for many years been one of their staple crops. More recently it has been introduced to the Gold Coast and is now the mainstay of that Colony.

Cinchona, also from South America, has been of great benefit to India and to Java.

Para Rubber (*Hevea*), which was brought from South America, is now an important source of revenue to Malaya.

Sisal (*Agave*), native of Central America, is now extensively planted in Kenya and Tanganyika and is a staple product in East Africa.

Cloves from the Spice Islands are the chief product of Zanzibar and Pemba.

Cotton has been introduced to various parts of the Empire, and is now a very important source of revenue to the Sudan, Uganda, Nigeria, etc.

The introduction of *Tea* from China to Ceylon and India has transformed vast areas of these countries and is a very important source of their revenue, while the introduction of *Coffee* to Jamaica and Costa Rica has resulted in important economic developments in those countries.

Reference may also be made to the introduction of *Wheat* to Canada and Australia, which has added so largely to the prosperity of these Dominions. Nor should we forget what the introduction of the *Potato* from South America, and the American *Tomato* has meant in the way of valuable foodstuffs and financial benefit to the growers of these plants in Great Britain and Eire, on the Continent of Europe and elsewhere.

Then, as one further example, there is the great bulb industry of Holland, where the growing of hyacinths and tulips especially, natives of the near East, has brought so much wealth to the country.

The problems raised by the introduction of economic plants from one country to another and their cultivation under plantation conditions provide ample occupation—apart from political considerations which may arise—for the plant pathologist, physiologist, agricultural chemist, the geneticist and systematic botanist. As the writer of the book Ecclesiasticus has so truly said, "When a man thinketh he hath finished, then he is but at the beginning, and when he ceaseth, then shall he be in perplexity".

OBITUARIES

Sir D'Arcy Power, K.B.E.

SIR D'ARCY POWER, who died on May 18, at the age of eighty-five, was first and foremost a writer. This was his finest asset. He gave evidence of this talent early in life, for when he was at the Merchant Taylors' School he won the Tyler Prize for history, and about the same time the prize for the boy best suited for a merchant's office. From that time almost to his death he wrote, and when at the age of seventy-five his works were collected in a complimentary volume, the items numbered more than six hundred.

He wrote on many subjects, though mostly in relation to his own profession. He wrote on the craft of surgery, on the history of medicine, biographies of past surgeons, and of such interesting details as the eyesight of Samuel Pepys and the reason why he discontinued his Diary, and how and when 'Surgeons' became 'Gentlemen'. He had a pretty pen and a happy phrasing, which make what he wrote a pleasure to read. He will be remembered by his writings long after more fashionable surgeons have been forgotten.

At St. Bartholomew's Hospital Sir D'Arcy became surgeon and consulting surgeon. At the Royal College of Surgeons he occupied successively all the more important posts. He was Hunterian lecturer, Hunterian orator, Vicary lecturer, and finally vice-president, as his father, Henry Power, was before him. But his activities did not cease there: he was an authority on Harvey and Hunter, a member of innumerable hospital and benevolent associations, a member of dining clubs and antiquarian societies, and a collector of books. The catalogue of the sale of his books at Sotheby's in the near future is an indication of his wide interests and catholic tastes. His circle of friends, both in Great Britain and abroad, especially in the United States, was immense; and he had a large post from all quarters requesting his help in all matters relating to medical historical research.

In his later years Sir D'Arcy occupied himself congenially and usefully as honorary librarian at the Royal College of Surgeons, there he compiled notices of the lives of the fellows, He was also archivist at St. Bartholomew's Hospital, where he was working on an incomparable set of deeds and documents dating back to the twelfth century, which have so far escaped fire and damage.

In his personal disposition D'Arcy Power was happy. He was full of cheeriness, so much so that students, often apt to discern, dubbed him "Sunny Jim", a nickname that stuck. Though he has now gone, and we miss him, we need have no regrets; for his life was pleasing and all our memories of him are pleasant. He was getting very tired, and was glad to lay down his pack. His seed, too, lives after him; for he leaves a son, D'Arcy, who holds a distinguished position in the medical service of the Royal Air Force; his grandson, D'Arcy Tertius, has entered the medical profession, and his granddaughter holds a commission in His Majesty's Forces.

G. E. Gask.

Mr. John Crompton, O.B.E.

Mr. John Crompton, president in 1937–38 of the Textile Institute, Manchester, died on May 31 at the age of seventy-eight. We are indebted to the *Textile Journal* for the following particulars. He was of the family that numbered one of the fathers of the cotton industry, namely, Samuel Crompton, the inventor of the cotton spinning mule. His father was a hand-loom weaver of silk fabrics, who eventually found his way into a cotton mill in Walkden, where his son joined him at a later date. It was from his father that John Crompton had his first lessons in cloth structure —a subject in which he perfected his knowledge at a later date by means of a model loom he devised. His studentship meant long and arduous study, but his tenacity of purpose and keen application overcame the many difficulties. He was one of the pioneers of technical education, first as a student and then as a teacher; eventually he became an examiner in his subject for the City and Guilds of London Institute.

Mr. Crompton contributed many articles to the technical trade press at a time when textile literature was very scanty. No doubt it was his appreciation of the lack of reliable information that caused him to welcome the advent of the Textile Institute, for which he did much useful work as a member of council for many years and of several of the Institute's committees. In 1930 he was awarded the Textile Institute Medal. He established in memory of his son, Lieut. Harry Dent Crompton, who was killed in the War of 1914–18, the Crompton Prize Fund for textile design. In 1923 the University of Manchester conferred on him the degree of M.Sc. in recognition of his work for the advancement of textile technology.

We regret to announce the following deaths:

Sir Francis Anderson, emeritus professor of philosophy in the University of Sydney, aged eighty-two.

Prof. A. C. Carson, of the Department of Geology, Mineralogy and Geography in the University of South Carolina, Columbia, distinguished for his contributions to seismology.

Dr. G. van Dijk, of the Royal Meteorological Institute of the Netherlands, noted for his work in seismology, on December 19.

Mr. G. R. Redgrave, formerly inspector of schools under the old Department of Science and Art, and later chief senior inspector of technical schools at the Board of Education, on June 14, aged ninety-seven.

Prof. J. E. Taylor, emeritus professor of thermodynamics in Cornell University, on May 4, aged seventy-six.

Dr. Eric Therkelson, head of the Department of Mechanical Engineering of Montana State College at Bozeman, and Collaborator in Seismology for the United States Coast and Geodetic Survey.

NEWS AND VIEWS

Sir Arthur Evans, F.R.S.

SIR ARTHUR EVANS, the well-known archæologist, celebrated his ninetieth birthday on July 8. He has been honorary keeper of the Ashmolean Museum since 1890, having been keeper during 1884–1908. Sir Arthur is undoubtedly the leading British authority in the classical archæological studies, for which he was awarded the Copley Medal of the Royal Society in 1936. In his earlier years he made important contributions to the science of numismatics. His researches in Crete from 1893 onwards resulted in the discovery of the remains of a civilization which he named Minoan after the sea-king, Minos. He traced the Minoan civilization from approximately 3200 to 1400 B.C. His work, "The Palace of Minos", published in six volumes, revolutionized our knowledge of the ancient history of the Near East.

On the occasion of Sir Arthur's ninetieth birthday, Prof. J. L. Myres and Prof. R. M. Dawkins, both former presidents of the Society for the Promotion of Hellenic Studies, presented him on behalf of the Society with an illuminated address. Prof. Myres also presented an address from the British School of Archæology in Athens, of which Sir Arthur was one of the founders and to which he presented some years ago the site of the Palace of Knossos and his property in Crete to be a centre for Cretan studies. Sir Arthur was president of the British Association during 1916–19 and of the Society of Antiquaries during 1914–19. He has been the recipient of many honours from British and foreign universities and societies. All readers of NATURE will doubtless wish to be associated with our congratulations to a scientific worker whose contributions to archæology and anthropology have been of such outstanding importance.

University of London: Air Raid Damage

SOME brief notes on damage done during air raids to buildings of the University of London have already appeared in NATURE (December 21, 1940, p. 802). Information has now been made available of further damage:

UNIVERSITY COLLEGE. Extensive additional damage. The libraries south of the Dome have been burnt out, and also the Exhibition Room, the General Office, the Provost's and Secretary's Rooms, the Council Room, the Botanical Theatre and the whole of the Mathematical Department above it.

KING'S COLLEGE. Damage from blast, fairly extensive in area, and a rough estimate for full repairs is £10,000.

KING'S COLLEGE OF HOUSEHOLD AND SOCIAL SCIENCE. Fairly extensive damage was done when a German bomber crashed on the College.

BEDFORD COLLEGE. Severe damage both by high explosive and incendiary bombs, to the administrative block, the Biological Science block and the Dining Hall. There is slight damage by blast to other parts of the buildings.

QUEEN MARY COLLEGE. Damage by blast in various parts of the building. The West Lodge in the forecourt had a direct hit and was demolished. A rough estimate of the cost of repairs of damage suffered is £5,000.

BIRKBECK COLLEGE. On the occasion of one attack, a small fire was started in the Department of Chemistry, but was brought under control. During one of the fire attacks on London, fires broke out in the surrounding buildings, but the main building of the College escaped; 90 per cent of the College library has been destroyed.

SCHOOL OF ORIENTAL AND AFRICAN STUDIES. Slight damage, mostly by blast, to new (unfinished) building.

MEDICAL SCHOOLS. *St. Bartholomew's Hospital Medical College:* The chemistry block, the old medical school buildings in Giltspur Street, the physiological block, including the library, students' common room, theatre and Pharmacology Department, have been completely burnt out. *St. George's Hospital Medical School:* Roofs of the large lecture theatre and library damaged, and a number of books destroyed. *London School of Hygiene and Tropical Medicine:* The eastern frontage has been completely wrecked: Minor damage by high explosive and incendiary bombs, and by blast, has also been done at St. Thomas's, Westminster, Middlesex, Charing Cross, University College and King's College Hospital Medical Schools, while the London School of Medicine for Women has lost £3,000 worth of furniture and equipment stored in Messrs. Thomas Wallis's depositories.

Social Reconstruction Survey

MR. GREENWOOD, Minister without Portfolio, has announced in the House of Commons that the Committee of the Social Reconstruction Survey consists of the following members appointed by the committee of Nuffield College:—Mr. G. D. H. Cole, reader in economics in the University of Oxford (chairman), the Master of Balliol, the Principal of Lady Margaret Hall, Prof. A. G. B. Fisher, Prof. D. H. Macgregor, Price professor of international economics of the Royal Institute of International Affairs, Prof. A. L. Bowley, emeritus professor of statistics in the University of London; Mr. R. C. K. Ensor, senior research fellow of Corpus Christi College, Oxford; Miss A. Headlam-Morley, and Mr. C. H. Wilson. The committee of the Survey has co-opted Dr. C. S. Orwin, director of the Agricultural Economics Research Institute; Miss Margery Perham, reader in colonial administration in the University of Oxford; Mr. G. Montagu Harris, research lecturer in public administration in the University of Oxford; and Prof. Patrick Abercrombie, professor of town planning in the Bartlett School of Architecture, University College, London.

The terms of reference of the Survey are, briefly to inquire into the rĕdistribution of industry and

population brought about by the War, and the extent to which this redistribution was likely to persist in the post-war period; into the effects of war conditions on the working of public social services (other than the hospital service); into the changes in conditions of living due to evacuation and similar measures taken to meet the war situation, and into the bearing of all these factors on the general problem of national re-organization after the War. The bulk of the expenses of the survey during the current financial year will be borne by the independent resources of Nuffield College, but the Government has undertaken to make a grant not exceeding £5,000 towards the expenses of the Survey in that year.

Provision of Fine Chemicals

Reference has already been made to the scheme inaugurated by the Advisory Research Council of the Chemical Society to facilitate the supply of fine chemicals needed for work of national importance, but which are not available commercially. The sub-committee organizing this work particularly desires to direct the attention of all users of fine chemicals to the existence of this scheme, in order that the greatest possible use may be made of the generous offers of help which have been received from numerous chemists in universities, technical colleges and schools, who have suitable laboratory facilities at their disposal. The scheme, which works in close collaboration with the Association of British Chemical Manufacturers, is an attempt to use to the best possible advantage both the laboratory facilities and the skilled man-power in teaching institutions and other laboratories which may not at present be fully harnessed to the war effort.

Before a substance can be accepted for preparation under this scheme, the Committee must be satisfied that the chemical is unobtainable from any British manufacturing firm and that it is required for urgent work of national importance within the British Empire. The scheme provides for the manufacture of approved items at basic charges which represent only the cost of raw material and such overheads as gas, electricity, etc. There is no charge for the chemist's services. Inquiries from both individuals and firms for chemicals which might be produced under the scheme should be made to the Secretary, Mr. S. E. Carr, Chemical Society, Burlington House, Piccadilly, London, W.1.

War and Industry in India

Comments on the relation of industry in India to the country's war effort are made in an article by J. C. Ghosh in the February issue of *Current Science*. Mr. Ghosh believes that Indian nationalists have a genuine grievance against the Government for lack of vision in dealing with industrial development. During the War of 1914–18, much encouragement was given to many new industries, and, in the post-war years, it was withdrawn on the grounds that only those industries likely to become independent of State support should be supported. Thus the industries commanding an abundant supply of raw material and a ready market for finished products, such as cotton, paper and cement, have gone ahead; unfortunately, this gain has been offset by decreasing prices and shrinking foreign markets for agricultural products. Mr. Ghosh's remedy for this state of affairs—and he thinks it is also a means of assisting defence measures—is to establish as key industries those which are included under the broad heading of metallurgical, engineering and machine tools, chemical and transportation industries.

Mr. Ghosh then discusses what has already been done in these fields. The Tata concern has been responsible for large developments in the iron and steel industry, and it is claimed that India could supply all the steel requirements of the countries represented at the Eastern Group Conference. Non-ferrous industries are not so advanced, but a plant for the production of aluminium with a capacity of 5,000 tons a year is being erected. Engineering is also backward. The heavy chemical industries are developing and may soon satisfy a large part of the country's requirements, but the dye-stuff and fine chemical industry is not satisfactory. The production in India is also urged of locomotives, ocean-going vessels and aeroplanes. It is stated that Indian industrialists fear that the manufacture of motor-vehicles is too difficult to be undertaken by Indian workmen in the near future, forgetting that "the thought and skill required in manufacture have been transferred from workmen to automatic machines". Non-official opinion in India is said, however, to be strongly in favour of starting such industries, and maintaining them as a part of the defence programme of the country.

Health of the Army in India

According to the annual report for 1939 on the health of the Army in India, there were no serious epidemics during the year among British or Indian troops, although civilian areas in which troops were placed suffered from cholera, plague, small-pox, dysentery, malaria and enteric fever. The hospital admission-rate among British troops was as large as 666 per 1,000 of strength during the year, and was an increase on the rate for the previous year, but the death-rate of 2·75 per 1,000 and the invaliding-rate of 9·14 per 1,000 were lower. Among the Indian troops the death-rate was also down, but the hospital admission- and invaliding-rates were up. This increase, however, was undoubtedly due to the conditions of war service and the return or influx of large numbers of men potentially infected with malaria and other prevalent diseases. Malaria and dysentery held the first place in the list of principal causes of sickness among British officers, and were followed by cellulitis and catarrhal jaundice. Malaria also held the chief place among soldiers, and next came cellulitis, and a good way down tonsillitis; but dysentery came sixth and was only half as frequent as a cause of admission as malaria. The prevalence of dysenteric infections was found to be due to lack of sanitation surrounding the troops' area. Respiratory diseases

were little in evidence, and there were no epidemics beyond minor outbreaks of mild influenza and pharyngitis. Nor was there any sign among the military population of the steady increase in tuberculosis which appeared to be occurring in the civilian population.

George Green Centenary

GEORGE GREEN, author of the famous "Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism", in which appeared for the first time what is now known as Green's theorem, died at Nottingham on May 31, 1841. The circumstances in which a miller was able to engage in mathematical research of fundamental importance have always puzzled the scientific world. New light has been thrown on the problem by Mr. H. G. Green, who has been investigating the matter for several years. In a lecture delivered at University College, Nottingham, to commemorate the centenary, he showed that at least one resident in the locality was well acquainted with the works of the great French mathematicians Laplace and Lagrange, and that the library of the Bromley House Society, of which Green was a member, had no difficulty, even in time of war, in obtaining copies of their researches. Among the members of this Society were several men of high learning and culture, who subscribed for the publication of Green's Essay in 1828. A full account of the investigations will be published in *Osiris*, the journal of the history of science, in due course.

Two French Botanical Pioneers

THE Botanical Garden at Montpellier has grown under the ægis of many distinguished botanists, some of whom made vast contributions to the science without the *éclat* of fame. Dora Maw provides, in a recent article (*J. Roy. Hort. Soc.*, **66**, Pts. 4 and 5, April and May 1941), a chapter of history which shows in vivid fashion the work of two earlier directors of the Montpellier Garden. Pierre Richer de Balleval (1564–1632) was the actual founder, and was a vigorous exponent of the rising science of pharmacognosy. He gathered together a consocies of 1,332 species, lost them during the military manœuvres of inter-religious strife, and started again with characteristic determination. Modern pharmacy owes to him the discovery of galenicals such as *Aristolochia longa, Artemisia campestris* and *Scrophularia aquatica*. Pierre Marie Auguste Broussonet (1761–1807) was a native of Montpellier, and became director of the gardens after a life of epic adventure. He travelled restlessly in south-western Europe and North Africa, after a thrilling succession of political reverses from posts of honour to expedient incarceration. Botanical awareness marked all his journeys, for he brought back knowledge of many useful plants—*Tetraclinis articulata* (citrus wood), *Argania spinosa* (iron-wood), *Acacia gummifera* (the source of gum arabic), and many species of medicinal value. His tenure of the directorship was relatively short, but the background of his extensive travels made it illustrious.

Statistics in Public Policy

MR. H. W. MACROSTY's inaugural presidential address to the Royal Statistical Society, which has now appeared in the *Journal* of the Society, in reviewing the evolution of official statistics in the last fifty years or so, emphasizes their importance for post-war reconstruction. Policy can only be sound if it is founded on a reliable ascertainment of all the facts. Society is never static; our theories must explain and conform to changes which appear to be spontaneously generated and our records must keep step with the changes. No trade policy has any chance of success which is not founded on the most careful study and understanding of the facts, and although the Economic Section of the League of Nations has already provided us with useful comparative studies of the course of international trade in the last twenty years, these do not appear to have penetrated far beyond the study and the lecture room.

Mr. Macrosty also doubts whether we have exhausted the methods of statistical analysis of trade data and whether something more of importance might be learned by the application of some of the methods of modern mathematical research. It is certain that, in the future, nutrition must form the basis of policy, even of international trade, and the repercussion of different lines of policy on each other must be carefully watched. Despite the researches of the last few years, we have still much to learn, and in the collection and study of what is yet unknown, as well as of what is at present known, statisticians are needed for the service of the future. Referring to gaps in our knowledge, Mr. Macrosty pointed out that we have still no quinquennial census; we know little about the distribution of incomes assessed for income tax except in the topmost range; we have no reliable figures of working class earnings and expenditure; calculations of the national income and of savings require much estimation; we have no census of distribution and the monetary and other suggestions of the Macmillan report have not all been adopted although nine years have passed. These statistics are of the most intimate importance for the determination of public policy.

Neanderthal Remains from Hither Asia

THE current number of *Antiquity* as usual contains several important papers. These include among others an article on "The Viking Taste in Pre-Conquest England" with excellent illustrations, and an account of "A Datable Ritual Barrow in Glamorganshire" by Sir Cyril Fox. But perhaps the most important information appears under the "Notes and News" and concerns a prehistoric find in Uzbekistan of flake tool industries associated with the remains of a Neanderthal child. Those who would like more details than this excellent précis can give should consult *Asia* (July and August, 1940) where A. P. Okladnikov has published two interim reports. The discovery itself was made in an immense rock-shelter called Teshik-Tash high up in the side of the Zautolosh Darya gorge not far from Tashkent and the Soviet-Afghan frontier. The rock-shelter is

61 ft. wide and 64 ft. deep ; it is above the contour-levels frequented by shepherds and herds, and so has remained undisturbed by modern intruders. On the other hand, the plentiful remains of wild mountain goats found in the deposits evoke no surprise. There were four black archæological levels separated by clay-like sterile ones, but the industries from bottom to top showed no great culture-change.

The tools are well made of local flinty limestone, quartzite, prase, etc., and include scrapers, disks, flakes and a sort of rough Audi knife (judging from the illustrations) as well as "utilised" bones. There were no real bone tools. It seemed not unreasonable to assign the whole industry to a late Mousterian culture, and this conclusion was confirmed when the skull of a 7–8-year-old child showing unmistakable Neanderthal characteristics was unearthed from definitely within the uppermost archæological level. A point of especial interest was that the skull appeared to have been partly surrounded by a ring of goats' horns arranged in pairs. Indeed, it seems evident that a ceremonial or ritual burial comparable to those of La Ferrassie in France had taken place as far away from western Europe as Tashkent. Geographically nearer, comparisons of implements can be made between the new Teshik-Tash finds and those of such Russian flake-tool sites as Chokurcha, Akhtyr, etc. ; but the appearance of a Neanderthal ritual burial puts the former in a different category, enables a more precise dating to be made, and is intrinsically exciting, opening up as it does new ideas as to the possible distribution of the Neanderthal race.

Radiography of the Chest in Recruits

AT a meeting of the Section of Medicine of the Royal Society of Medicine on May 27, Dr. Philip Ellman read a paper on "Mass Radiography of the Chest in the Early Detection of Intrathoracic Disease, with Special Reference to Pulmonary Tuberculosis in Recruits", in which he maintained that this method offers an invaluable contribution to preventive medicine. He recorded some results which he had obtained by (1) full-sized radiograms, (2) fluoroscopy and (3) miniature screen photography, the last being the most practical means of carrying out mass X-ray examination of the chest. As the result of his experience of this method with control experiments with full-sized radiograms, he suggested that for correct interpretation miniature screen photography demands a technically satisfactory film, which involves the closer co-operation of technician, radiologist and chest physician. The method offers an invaluable contribution to the detection of pre-clinical asymptomatic pulmonary lesions in a presumably healthy population. It can therefore add much to the prevention and control of pulmonary tuberculosis—in war by the examination of recruits, and in peace by the examination of selected groups of the population, for example, where pulmonary tuberculosis is known to be frequent and in certain trades where the pneumokonioses are known to be common. In dealing with the application of the method to cardiology in the detection of cardiovascular lesions, Dr. Ellman urged that serial examinations should be made, and that its general adoption in routine health examinations will be of great value.

The Farmers' Club Library

THE Farmers' Club (2 Whitehall Court, London, S.W.1) has recently added considerably to its library. To extend the use of it, a loan service is being instituted by which members (now numbering 1,320) may borrow books, free of charge. A classified catalogue of the library has been printed, and supplemental lists will be added from time to time. The range of subjects covered is comprehensive, and the dates of publication extend from the eighteenth century up to the present day. Suggestions for additions to the library will be welcomed from members, and inquiries for books not listed in the catalogue may be made as they may be obtainable from other sources. The addition of an author index in any further issues of the catalogue would add considerably to its value

River Flow Records

IT is now two years (June 3, 1939) since there was noticed in these columns an annual report (the third) on Inland Water Survey in Great Britain, issued by the Ministry of Health and the Scottish Office. Unfortunately, there seems to be little or no likelihood that further reports will be published at present. This abrupt cessation of the reports makes a serious hiatus in the useful work of the Survey, which was begun by the Government in 1935 at the instance of the British Association and the Institution of Civil Engineers, and it is greatly to be regretted from a hydrological point of view, since the data collected were, undoubtedly, of great value for a properly systematized estimation of the water resources of the country. To remedy the omission in some measure, Captain W. N. McClean, the director of River Flow Records (Parliament Mansions, Victoria Street, S.W.1), to whose initiative and enterprise the institution of the Survey is due, has just issued a small pamphlet of ten sheets, entitled "River Flow Records of the River Moriston at Invermoriston", giving recorded readings of that river in Inverness-shire during the years 1937–40, in continuation of those which have previously been recorded since 1929. Both water-levels and river flow have been tabulated daily for each month of the period to September 1940. The relationship between them has been established at Invermoriston for any water-level up to an ordinary high flood. Extreme low flow may drop to less than 30 cu. ft. per sec., and an extreme high flood may reach a flow of 16,000 cu. ft. per sec. The area drained is 151 square miles and the run-off for a year of average rainfall is estimated to be about 68 inches. Captain McClean's persistent and painstaking efforts in maintaining these scientific observations are deserving of the highest commendation. It is greatly to be desired that publication of the results of the national survey should be resumed as soon as possible.

Automatic Electrical Farm Boiler

In the *Electrical Review* of June 6, Mr. Theodore Rich gives a complete description of an apparatus developed particularly in the province of Brandenburg in Germany whereby steamed potatoes are prepared for pig food. The steamer consists of a galvanized cylindrical vessel, with an insulating jacket and lid. It is mounted on bearings like a churn, and is fitted with a tipping-locking lever. Three sizes are made for about 80, 155 and 308 lb. of potatoes respectively. The potatoes and necessary water are put in at night, and thanks to automatic control, the potatoes are correctly cooked by the early morning. The food keeps warm throughout the day without the apparatus being switched on and the operational cost is low owing to the special low night rates. The apparatus is protected against running dry. It is claimed that the floury product is much liked by stock.

Basic Costs in Electricity Supply

One of the principal problems in the management of public electricity supply companies is how to reconcile the costs with the charges not only from year to year but also in their irregular secular changes. Cost data are a matter of fact, but the application of such facts to the special circumstances of individual cases is often a question of policy. There are many ways of segregating and arranging cost data, although any process of segregation so far as electricity is concerned is entirely empirical. Some method of averaging has necessarily to be adopted, and probably the greatest difficulty lies in the determination of the proper allowances to be made for load diversity. As Mr. G. D. Bond points out in the *Electrician* of May 2, each extension of the field of development makes the problem harder, and it is hardest when the variety of the load on the public network is the greatest. A modern factor which increases the difficulty of diversity-measurement is arising in those undertakings, where, owing to the development of new loads, there is a consequent shift in the time of incidence of the peak-load.

In addition to the short-term division of costs as 'fixed' and 'running', there is a long-term division of costs into 'differential' and 'residual' costs. This latter division of costs may be explained by considering the domestic and commercial development of load, which is necessarily a long-term process. Up to a point, extra supplies can be given without recourse to additional capital expenditure (particularly when the demands are extensive and not intensive); later on, as local network difficulties arise, some fortification of mains is required, until at a later stage heavy capital expenditure is needed to cope possibly with peak loads of relatively short duration. At this point, the short-term supposition of cost incidence becomes invalid because the differential cost of giving the extra supplies is higher than the residual cost. With intensive development the differential cost decreases provided selective loads are taken to improve consumers' loads and diversity factors.

Franklin Institute Medallists

The complete list of medal awards by the Franklin Institute (see NATURE, July 5, p. 19) is now available: *Franklin Medals:* Sir C. V. Raman; Prof. E. H. Armstrong, professor of electrical engineering, Columbia University; *Cresson Medal:* The United States Navy, received by the Hon. Ralph A. Bard, assistant secretary of the Navy, Washington, D.C.; *Potts Medal:* Prof. H. E. Edgerton, associate professor of electrical engineering, Massachusetts Institute of Technology; *Levy Medal:* Profs. J. M. Lessells and C. W. MacGregor, of the Massachusetts Institute of Technology; *Clark Medal:* Raymond Mower Conner, director of the Testing Laboratories, American Gas Association, Cleveland; *Brown Medal:* W. H. Carrier, chairman of the board, Carrier Corporation, Syracuse; *Wetherill Medal:* H. S. Black, Bell Telephone Laboratories, New York City; *Longstreth Medal:* B. J. Wilson, chief of the mechanical division, Research Department, Leeds and Northrup Company, Philadelphia.

Magnetic Storm

A magnetic storm was registered at Abinger on July 5. The storm began at 6 hr. and remained intense until 16 hr. G.M.T. The range in declination was 1° 17′; in horizontal intensity, 950 γ; in vertical intensity, 745 γ.

Announcements

Prof. Emil Abderhalden, professor of physiology in the University of Halle, has been made an honorary member of the Société de Physique et d'Histoire naturelle of Géneva.

Prof. Piccinini has founded an Institute for the History of Medicine at the University of Milan, where he occupies the chair in that subject.

The University of Oxford is making a grant to the Department of Chemistry to carry out a nutritional survey and a study of antiseptics in relation to burns.

The Ministry of Health is arranging for children attending clinics to have black currant syrup made from a formula drawn up by the Long Ashton Research Station (University of Bristol). Black currants are well known to be very rich in ascorbic acid, and the syrup is stated to contain five times the vitamin C content of orange juice.

The British Psychological Society is arranging a whole-day meeting to be held in London on July 26 to discuss psychological problems of air-raid shelters and evacuation. Those interested should communicate with the honorary general secretary, Mr. R. J. Bartlett, 14 Barchester Road, Harrow Weald, Middlesex.

According to the latest report of the Registrar-General the highest marriage-rate ever known in Great Britain occurred in 1940. Marriages in England and Wales totalled 468,267 and exceeded the record figure in 1939 by 28,573; the marriage-rate per 1,000 of the population was 22·6, and the previous highest rate except for 1939 was 20·2 in 1920. During the War of 1914–18 the highest marriage-rate was in 1915.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Trunk Diameter of Trees of *Hevea brasiliensis*: Experiments with a New Dendrometer

A SENSITIVE dendrometer was designed and constructed at this Institute to study the daily changes which occur in the trunk diameters of rubber trees, and the extent to which the outflow of latex on tapping affects the diameter in the region of the cut. For this purpose there was required an instrument more sensitive than the self-recording dendrograph of MacDougal[1], but optical methods of magnification (*cf.* Mallock[2]) were precluded on account of the difficulty of setting up, protecting and operating the dendrograph in the plantation.

The new instrument consists of a steel U-shaped braced member which carries a system of three levers connected in series, the last one being similar to the Dye optical lever[3] but carrying a light pointer, moving over a scale instead of a mirror, giving a total magnification of about 450. The design of this lever system follows modern practice for precision measuring instruments, all bearings being of kinematic design and the linkages consisting of steel strips so as practically to eliminate friction and backlash. As nickel-iron alloys of low thermal expansion were not available, compensation for expansion of the steel frame was provided by a zinc rod of appropriate length in the lever system, which reduces temperature errors to a negligible value. The instrument can measure rapid small changes of diameter to a limit of about 0·0005 mm.

In use, small metal studs are cemented with grafting wax to scraped areas of the trunk diametrically opposite to each other. The contact points of the instrument, which are 5/32 in. diameter steel balls, engage in trihedral sockets in the studs so as to provide positive location, and the instrument is suspended by chains or wires attached higher up the trunk so that the frame lies horizontally.

Trunks of Hevea trees are found to show a daily variation in diameter similar to that found by MacDougal[1] for many trees of the temperate zone, namely, a rapid diminution starting soon after sunrise or when the sun first strikes the crown of the tree (about 7.00 a.m. Malayan time) and continuing at a diminishing rate throughout the morning and afternoon, tailing off to a minimum between 2 and 3 p.m., followed by a rise which continues during the evening and very slowly throughout the night, reaching a maximum shortly before dawn. This curve closely follows that of atmospheric relative humidity. The daily variation is greatest on hot bright days, when the reduction in diameter at five feet above ground, of a trunk 20 cm. in diameter, may be as much as 0·25 mm. between 8 a.m. and 2 p.m. On rainy or overcast days the total reduction may be only half as much. The trees respond remarkably quickly to changes of insolation; thus in one observation during overclouding of the sun at noon for 22 minutes, a trunk increased in diameter by 0·007 mm., although previously it had been steadily decreasing. An increase was apparent in the dendrometer reading within two minutes of the sun being obscured.

The immediate effect of tapping is clearly shown by the dendrometer. No effect is observed on an instrument mounted above the cut, but on one placed just below a rapid decrease of diameter begins within a few seconds and is often almost complete within 3 minutes of opening the tapping cut. The amount of this shrinkage varies from tree to tree and also appears to depend upon the period since the last tapping and upon the time of day of tapping, but it is usually about 0·03 mm. The effect is less at 50 cm. below the cut but is still quite distinct, and can usually be detected at 75 cm. but not definitely at 100 cm., upon the trees used so far.

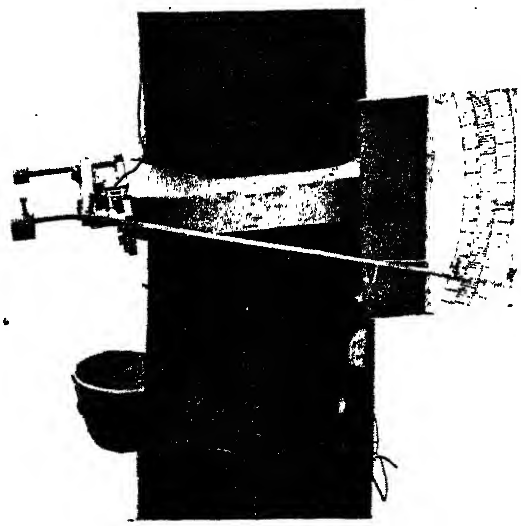

Fig. 1.

FRONT VIEW OF DENDROMETER TO REAR OF TAPPING PANEL.

In early morning tappings, that is, tapping at about 6.30 a.m., the dendrometer records show a recovery to almost the original diameter within about 1½ hours after tapping. A further effect is, however, frequently shown by the tapped tree during the morning and early afternoon following tappings, especially if the weather is hot and dry and no rain has fallen for several days. This is a considerably greater reduction in diameter compared with the records for 'resting' days or with an untapped control tree. Insufficient data have so far been obtained, however, to state definitely whether this effect is general or is a peculiarity of the tree at present under observation.

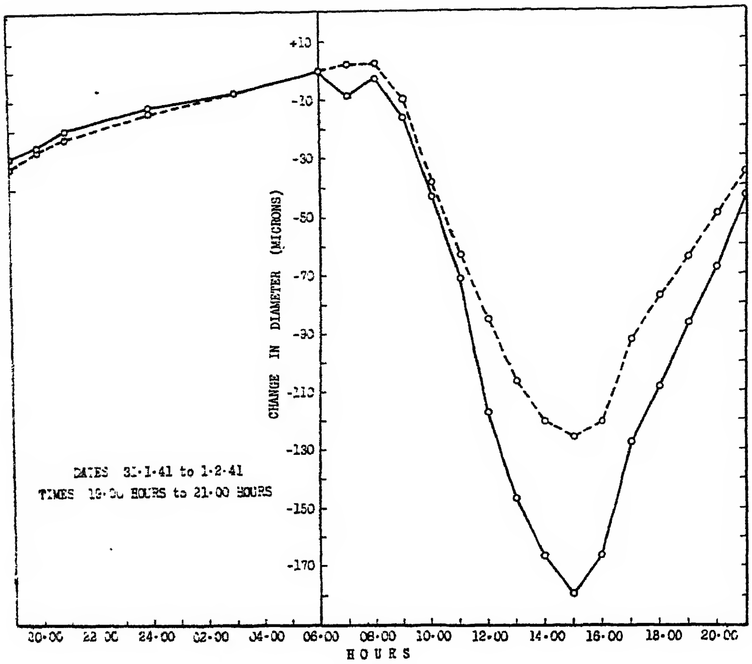

Fig. 2.

GRAPHS OF CHANGES OF TRUNK DIAMETERS IN THE PERIOD OF 19.00 HOURS (31 . 1 . 41) TO 21.00 HOURS (1 . 2 . 41) OF TWO TREES; DENDROMETERS ATTACHED TO EACH AT 84 cm. ABOVE GROUND AND JUST BELOW TAPPING PANELS. *Continuous line:* TREE A, GROSS DIAMETER 19·9 cm. IN 'ALTERNATE-DAY' TAPPING (TAPPED AT 06.35 HOURS, 1 . 2 . 41); *broken line:* TREE B, GROSS DIAMETER 19·6 cm. NOT IN TAPPING DURING THE EXPERIMENT, ACTING AS CONTROL TO A.

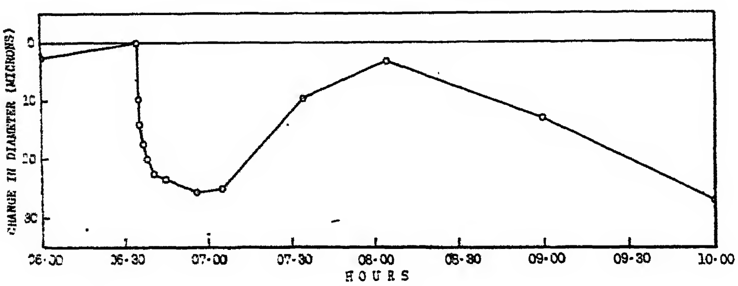

Fig. 3.

IMMEDIATE EFFECT OF TAPPING ON TRUNK DIAMETER JUST BELOW THE TAPPING PANEL. THE TREE TAPPED AT 06.35 HOURS (19 . 2 . 41) SHOWING A REDUCTION OF 25·5 μ WITHIN TWENTY-ONE MINUTES, AND ALMOST COMPLETE RECOVERY WITHIN $1\frac{1}{2}$ HOURS OF TAPPING.

This investigation forms part of a programme of research on the physiology of latex, which was begun at South Kensington under the direction of Prof. V. H. Blackman, with a grant from the Rubber Growers' Association, and is now jointly supported by the British Rubber Producers' Research Association and the Rubber Research Institute of Malaya.

E. E. PYKE.

The Rubber Research Institute of Malaya,
Kuala Lumpur.

March 1.

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Relative Growth in the Individual

IN view of the criticism[1] that a curve of relative growth derived from contemporaneous data on many individuals of all sizes (population curve) may not apply to actual growth in the individual, as is frequently assumed[4], data on the latter are much to be desired[2]. From careful measurements on series of moults of individual *Carcinus mœnas*, populations of which have been much used for relative growth studies[3, 4], the following conclusions seem to be justified.

(1) Simple allometry[5] does apply to growth in the individual, and is not merely a feature of the population curve; straight-line graphs are obtained by log/log plotting of one dimension against another (see graph on p. 53). For carapace-length/carapace-width in No. 1 there is a single phase of simple allometry from metamorphosis at 1·7 mm. carapace length to the moderately large adult at 45·5 mm. The fitting of the points is so close that these further conclusions are probably justified, in spite of the small number of individuals.

(2) For 'frontal-width'/carapace-width there are two phases of simple allometry (accompanying graph, No. 1). The transition occurs abruptly at a certain moult (the fifth—unfortunately missing from the series). The gradual transition usually seen in population curves may therefore be due to individual variation in body size at transition[6].

(3) For 'dentary-margin'/carapace-width there are similarly two phases, but transition occurs at the third moult, and is therefore probably quite independent of that for frontal width (in these early stages dentary margin is almost a length dimension).

(4) The curve of relative growth between two particular dimensions shows variations in different individuals. There may be variations only in the constant b of the allometry equation $y = bx^{\alpha}$, giving two parallel curves (accompanying graph; Nos. 2, 3; *C.L./C.W.*), or in α also (accompanying graph; Nos. 2, 3; *F.W./C.W.*), in different pairs of dimensions of the same two individuals.

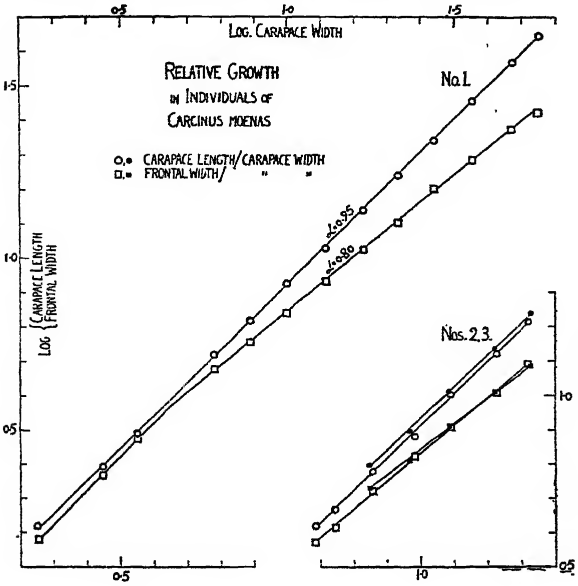
Concerning absolute growth the following points are worth recording:

(5) The increase in body size after each ecdysis is in accord with Brooks's law[7], the constant factor of geometric increase being very near Przibram's constant ($\sqrt[3]{2}$, = 1·26)[8]. The absence of moults 2, 5 in No. 1 is clear. There are small individual differences in the factor.

(6) By contrast to body size the intermoult time increases very irregularly. There is, however, a suggestion of orderliness in a large body of data, and of

a change, about 8 mm. body size, to a more rapid rate of increase. In Corophium[2] the intermoult time is constant over the whole of post-embryonic life.

Data from two short series of both *Maia squinado* and Stenorhynchus sp., and from other short series of Carcinus, essentially support the above conclusions.



(7) In Carcinus No. 1, a female, a record was obtained of the growth in width of the abdominal segments relative to carapace-length, though less complete than that of the carapace dimensions. For the abdomen 1 segment there is a single phase of simple allometry ($\alpha = 1\cdot07$), but for other segments three phases, with the two transitions at approximately 2·5 and 12·5 mm. body size (? metamorphic and adolescent transitions). The transitions are abrupt but the data did not show this to be simultaneous in all segments, possibly owing to the incompleteness of the data. The growth-centre is in abd. 3 segment during the short first phase and in abd. 6 throughout the rest of growth ($\alpha = 1\cdot5$ for 3rd phase) (*c.t.*[3]).

I am indebted to Dr. I. Gordon for the use of the material, from the British Museum Collection.

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June 10.

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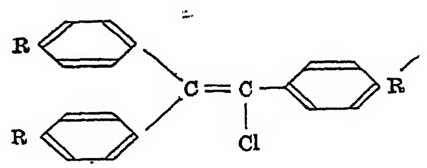
Preparation of Triphenylchloroethylene*

The preparation of triphenylchloroethylene has been effected in various ways [1, 2, 3, 4, 5, 6]. A better mode of preparation of the compound seems to be through the following series of operations.

* Abridged.

To the Grignard reagent prepared from magnesium (12 gm.), benzyl chloride (60 gm.) and ether (250 c.c.), benzophenone (60 gm.) was added, and after two hours' stirring the solution was left for two hours more and then decomposed with cold aqueous ammonium chloride. Ether extracted the carbinol[7] which separated from petroleum (b.p. 70–80°) in colourless crystals m.p. 88–89°. Yield was 80–85 gm. The triphenylethylene[7,8,9] was best prepared by the vacuum distillation of the carbinol (100 gm.) in presence of 2 drops 20 per cent sulphuric acid. It separated from alcohol in colourless crystals m.p. 70°. Yield was 75 gm. To prepare triphenylchloroethylene, sulphuryl chloride (35 gm.) and a solution of triphenylethylene (50 gm.) in carbon tetrachloride (25 c.c.) were mixed together and benzoyl peroxide (0·2 gm.) was added. The solution was refluxed on a water bath for forty-five minutes, excess of sulphuryl chloride was distilled under reduced pressure, and the oily residue was recrystallized twice from alcohol. The mother liquors were concentrated, and the oily material which thus separated was again recrystallized from the same solvent. Triphenyl chloroethylene (45 gm.), m.p. and mixed m.p. 117° was obtained in colourless crystals.



The preparation, on similar lines, of compounds related to triphenylchloroethylene (where R=H. Cl, Br, COOH, Me, MeO, EtO, $\overset{\alpha}{\text{Pro}}$, $\overset{\beta}{\text{Pro}}$, etc., and R′= H, Cl, Br, COOH, Me, MeO, etc., in the formula above) is now in progress.

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May 3.

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Catalytic Aromatization and Isomerization of 2.2.4.-Trimethyl Pentane

Hoog, Verheus and Zuiderweg[1] have concluded generally that paraffins with structures not readily permitting the formation of a six-membered carbon ring are not appreciably aromatized or isomerized over cyclization catalysts. While studying the cyclization of hydrocarbon mixtures in these laboratories, however, it was found that at 550° C. with a liquid catalyst-space velocity of 0·33 c.c./c.c./hour

and a 6 atomic per cent molybdenum oxide-activated alumina catalyst in a mild steel catalyst tube, considerable formation of aromatics from pure 2.2.4. trimethyl pentane resulted, accompanied by cracking. The aromatics contained mixed xylenes, *o*-xylene being identified, together with some naphthalene.

The full results will be published elsewhere.

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Use of the Term 'Resolving Power' in Spectroscopy

THE classical description of the limit of applicability of an instrument by the resolving power $\lambda/d\lambda$ has been used in spectroscopy for many years in spite of very obvious drawbacks. Since the advent of the Bohr theory of spectra, the spectroscopist is not concerned with *wave-lengths* but with *frequencies* and *frequency differences*. If a concept of the power of instruments to resolve close lines is adopted in terms of frequencies, there results a considerable improvement in clarity and in practical applicability.

Consider as typical examples the use of a Fabry–Perot interferometer and of a grating to separate close components. The interferometer, air gap of thickness $t = 1$cm., is coated with aluminium mirrors having a uniform reflecting coefficient between 5,000 A. and 10,000 A. The grating has 100,000 lines to the inch and is to be used in the first order. Consider the use of the instruments for the resolution of close lines at 5,000 A. and 10,000 A.

With the interferometer the frequency difference which can be resolved at any wave-length is $d\nu = dn/2t$; that is, resolution depends only upon the fraction of an order dn which can just be separated with the gap used. This does not involve the wave-length if we have a uniform reflecting coefficient (the same is effectively true with the Lummer plate). The *shapes* of the fringes at 5,000 A. and 10,000 A. can be considered to be identical and as a result the *same* frequency difference can just be resolved at these two wave-lengths, or at any in between. The effectiveness or practical 'power' of the instrument is therefore *uniform* over the whole range. But if we evaluate $\lambda/d\lambda$, we find that the resolving power in the strict classical sense increases regularly with diminishing wave-length, being in fact twice as great at 5,000 A. as at 10,000 A. Clearly, as a description of the effectiveness of the instrument the resolving power is undesirable and should be modified.

With a strictly monochromatic source any instrument produces an apparent line width, owing to diffraction, etc., and it is, of course, this which sets the lower limit to the resolution. Instead of regarding this width as a wave-length difference, the frequency difference should be considered.

I propose that instead of using resolving power we define the ability of an instrument to resolve lines at any wave-length by $d\nu = \nu.d\lambda/\lambda$, that is, by the *instrumental line width in cm.*$^{-1}$ *at that wave-length.* This quantity, being equal to the wave number of a line divided by the classical value of resolving power, can readily be evaluated. A convenient name for this quantity would be the *resolving limit*, and it will be seen that it is a practical measure of the effective applicability of an instrument and in actual practice of more use than the classical resolving power. Thus in the interferometer, the line width is a certain fraction of an order (depending only upon the reflecting coefficient) divided by twice the gap. With a good instrument a fringe is 1/20 of an order wide; hence for the case under consideration the *resolving limit* is 0·025 cm.$^{-1}$ over the whole range 5,000–10,000 A. This is a practical index of the performance.

That the proposed new definition is superior to the classical resolving power is clearly demonstrated by considering the grating. The resolving power $\lambda/d\lambda = nm$ (in this case 100,000) is uniform over the whole wave-length range. On the other hand, the *resolving limit*, the *smallness* of which is the significant criterion, is proportional to ν, its value being $d\nu = \nu/nm$. It is thus half as much at 10,000 A. (namely, 0·1 cm.$^{-1}$) as at 5,000 A. (0·2 cm.$^{-1}$). It is therefore clear from this quantity that the farther one goes in the infra-red the better adapted is a grating for the resolution of close structures. This is a property not immediately obvious from the classical definition of resolving power, and rarely emphasized.

These two simple examples suffice to show that the classical resolving power as an index of an instrument should be replaced, for similar difficulties arise with any instrument employed over a wide wave-length range.

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Physics Department,
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June 21.

"'Pancake' Ice in the Pennines"

SINCE my letter on the above subject was published in NATURE of May 3, I have received one or two communications commenting on the phenomenon, to which it may be of further interest to refer.

Mr. R. I. Lewis has kindly directed my attention to a note by his friend Mr. D. J. P. Phillips, of University College, Cardiff, which appeared in NATURE of February 5, 1914, under the title "A Curious Ice Formation". Having now had the opportunity of referring to the latter, I find that the short description given suggests quite clearly a parallel occurrence of 'pancake' ice formed under similar, though somewhat more artificial, conditions to those I described at High Force in Upper Teesdale. Mr. Phillips's illustrated example exhibited circular floes of ice encrusted with snow and having the appearance of water-lilies. They were found in the River Ure at Brecon where it had just passed over a weir, and they were apparently formed following the night of December 31, 1913, when 14° of frost had been registered locally.

From Mr. Henry Bury, of Bournemouth, I have received a short description of 'pancake' ice seen by him on January 23, 1933, on the River Loire at Gien (Loiret). He records that circular rafts of ice estimated at 4–6 ft. diameter, and covered with snow, were being carried along in a flooded and swiftly flowing river. The whirling motion imparted to these rafts, and the frequent collisions between them, were, in Mr. Bury's opinion, sufficient to account both for their form and for their conspicuous raised borders.

Consequently, it would seem amply clear that, under suitable and sufficiently 'rigorous' conditions, 'pancake' ice can be formed in other than the polar regions.

N. E. ODELL.

RESEARCH ITEMS

Distribution of types of *C. diphtheriæ*

H. D. WRIGHT has analysed the incidence, severity and age-distribution of 8,040 infections caused by the three types of *Corynebacterium diphtheriæ* (*J. Path. and Bact.*, **52**, 283–294; 1941). The cases were notified in Liverpool during the four years 1937–1940; and there were 475 deaths (5·9 per cent). The *mitis* type was cultivated from 29·8 per cent, the *intermedius* type from 18·9 per cent, and the *gravis* type from 51·3 per cent of the total cases of diphtheria in the period under review. The figures show that the incidence of the *gravis* type increased each year from 34·2 per cent in 1937 to 69·6 per cent in 1940, but that the *mitis* and *intermedius* incidence correspondingly decreased. The proportion of the *mitis* cases in each year that were included within the age-group 0–4 was higher than that of the *intermedius* and the *gravis* cases in this age-period; and, similarly, the *intermedius* percentage figures were higher than those of the *mitis* type for the ages 10–14. The case-fatality rate, over the whole period, of infections with *mitis* was 2·2 per cent; for *intermedius* it was 10·7 per cent; and for *gravis* it was 6·3 per cent. The proportion of toxic cases was considerably greater in the *intermedius* and *gravis* groups than in the *mitis* group. The author discusses the validity of subdividing strains of the diphtheria bacillus into the above-mentioned types. This classification originated ten years ago in Leeds and has been widely confirmed, although critical reports have recently come from the United States. The Liverpool experience has convinced Wright that the types are founded on well-established criteria; that, with practice, they are readily distinguishable; and that they serve a useful purpose in helping to make clear the pathological and epidemiological features of the disease.

Isotopic Constitution of Potassium *in vivo*

POTASSIUM is known to have three natural isotopes $^{39}_{19}K$, $^{40}_{19}K$ and $^{41}_{19}K$. The 39 isotope represents the bulk of the element, the 41 isotope a relatively small fraction, while the radioactive 40 isotope occurs only in minute quantity. It is known that the abundance ratio of the 39 and 41 isotopes is not a constant figure for all organic tissues. A. Lasnitzki and A. K. Brewer (*Biochem. J.*, **35**, 144; 1941) have now studied the isotopic constitution of potassium present in various rat tissues by mass-spectrographic measurement on the ash. In the living animal a continuous potassium exchange takes place between the various tissue cells and the blood plasma. The actual potassium content of tissues is on the average perhaps twenty times higher than that of blood plasma. It was found that the isotopic ratio $^{39}_{19}K/^{41}_{19}K$ in the ashes from bone marrow and blood plasma was distinctly lower than that of ordinary mineral potassium (purified KCl) or from the ashes of other tissues. A kinetic mechanism has been proposed accounting for the observed effect depending on the condition that the intracellular potassium, in contrast to the extracellular potassium, is completely associated with heavy molecules. A fractionation of the 39 and 41 isotopes due to the difference in velocity of the ions in their passage through the cell membrane thus occurs. The isotope ratios of tissue potassium and plasma potassium do not depend solely on the mechanism responsible for their difference, but also on the isotopic ratio of the potassium which enters the blood-stream via the intestine. Fractionation of isotopes due to slight differences in chemical properties can be obtained by exchange reactions. Thus if zeolites containing sodium as a basic constituent are brought into contact with solutions of lithium or potassium salts, the sodium is exchanged for lithium or potassium, but the light isotope of lithium and the heavy isotope of potassium are taken up preferentially.

Genetics of Cotton

S. C. Harland and O. M. Atteck (*J. Gen.*, **42**, 1–21; 1941) have given important facts regarding the genetics of cotton. They have been able to introduce genes from the diploid *Gossypium Thurberi*, *G. Armourianum* and *G. aridum* to the tetraploid *G. barbadense* and *G. hirsutum*. By continual back-crossing they were able to study the effect of one gene on the background of *barbadense* and *hirsutum*. The *Armourianum* petal spot due to S^{arm} was proved to be an allelomorph of *hirsutum* R^h. On a *hirsutum* background, the size of the petal is not reduced in size or intensity. S^{ari} of *G. aridum* is another allelomorph of R^h. The character is reduced on a *hirsutum* background, where it becomes mutable, although it is stable in *aridum*. The evidence that S^{ari} of *aridum* and S^{arm} of *Armourianum* are allelomorphic to R^h of *G. hirsutum* provides proof that the tetraploid New World cottons contain two genoms of Asiatic and North American affinities respectively.

Sex-linked Albinism in the Fowl

A USEFUL new gene (*al*), giving a dingy white, pink-eyed chick, is reported by C. D. Mueller and F. B. Hutt (*J. Hered.*, **32**, 71–80; 1941). As the fowls grow, some melanin is found in the eye and a ghost pattern may be seen on the plumage. Sight, viability and productivity appear to be normal. The gene is sex-linked and raises to nine the number of genes known to be carried on the sex chromosome. It is highly probable that the mutation was found in the first generation after its occurrence.

Cyanogenesis in Lotus

ONE form of *Lotus corniculatus* liberates hydrogen cyanide when its leaves are killed, while another form morphologically indistinguishable from the first is acyanogenetic. Cyanogenesis is inherited in a tetrasomic manner as a dominant (C. D. R. Dawson, *J. Gen.*, **42**, 49–72; 1941). The observed numbers approximate to those expected on chromosome segregation. Cytological examination shows that this species is a tetraploid with $2n = 24$ chromosomes, but that quadrivalents are rare. The author points out that genetical data of segregation are safer than cytological as a criterion of autopolyploidy. It is considered that *L. tenuis*, which also has both acyanogenetic and cyanogenetic forms, is a diploid relative of *L. corniculatus*.

Reaction of Aliphatic Amines with Nitrous Acid

IT might be assumed that primary aliphatic amines of low molecular weight would react easily with nitrous acid to form primary alcohols with liberation of nitrogen according to the equation: $RNH_2+HNO_2=ROH+N_2+H_2O$, and this reaction has been shown to occur with butylamine to the extent of 25 per cent. Very little information is available on the general aspects of the reaction. F. C. Whitmore and R. S. Thorpe (*J. Amer. Chem. Soc.*, **63**, 1118; 1941) have examined the effect of nitrous acid on methylamine, ethylamine and *n*-propylamine under varying conditions. In sixteen experiments with methylamine and nitrous acid under a wide variety of conditions, no methyl alcohol or other reaction product could be isolated from the reaction mixture, some methylamine being always recovered unchanged. The amount of unchanged amine was never less than 25 per cent, and was sometimes more than 90 per cent, although conditions like those employed with *n*-butylamine were used in several cases. Solvents other than water were also used, and a reaction in the gas phase with methylamine, nitrous vapours and a trace of moisture was attempted. The amine nitrite seems to be more easily hydrolysed than decomposed. Small amounts of methyl alcohol were obtained with silver nitrite and methylamine hydrochloride. Ethylamine with nitrous acid gave a 60 per cent yield of ethyl alcohol; *n*-propylamine gave 7 per cent of *n*-propyl alcohol, 32 per cent of isopropyl alcohol and 29 per cent of propylene. Traces of ether were also formed with ethyl and propyl amines.

The Antimony Electrode

MANY investigations have been carried out on electrodes of the metal–metal oxide type. The only one of them which has met with much success is the antimony–antimony oxide electrode. The values reported in the literature for the standard potential and the slope of the *p*H curve vary widely. F. Hovorka and G. H. Chapman (*J. Amer. Chem. Soc.*, **63**, 955; 1941) have obtained very satisfactory antimony electrodes by casting pure antimony (obtained by electrolysis from hydrofluoric acid solution) into sticks under reduced pressure. These castings were free from surface pits and were very lustrous; they were cleaned by electrolysis in sodium carbonate solution and repolished before use. The sticks were immersed directly in the buffer solutions and the other electrode was a hydrogen electrode. It has been known for some time that it is unnecessary to add any antimony oxide. The potential at 25° was found to be $0{\cdot}2552 - 0{\cdot}05893\ p\text{H}$ referred to the normal hydrogen electrode, a deviation of the potential at $p\text{H}=8$ reported by other investigators being confirmed. Between *p*H 2·2 and 8 the slope of the curve was constant, and the value 0·05893 is quite close to the value 0·05912 predicted by the Nernst equation.

Heat Capacity of Nickel Sulphate

ONE of the more important problems arising from the use of the third law of thermodynamics is the persistence of multiple electronic states in some solids at low temperatures. This is indicated by a change of magnetic susceptibility with temperature. Heat capacity measurements give no indication of the entropy contribution due to these states unless they are carried to such low temperatures that the electronic contribution is 'frozen out'. In a study of the heat capacity and magnetic susceptibility of nickel sulphate heptahydrate, $NiSO_4$, $7H_2O$, at liquid helium temperatures, Stout and Giauque (*J. Amer. Chem. Soc.*, **63**, 714; 1914) find that the electronic system makes a large contribution to the heat capacity at temperatures where the lattice energy is unimportant, and there is a maximum in the heat capacity about 1·8° abs. The entropy contribution associated with the electronic system is shown to be R ln3, which shows that the system has three electronic levels. These are about equally separated by about 2·6 cm.$^{-1}$, equivalent to 7·4 cal. mol^{-1}. The character of the heat capacity curve of the substance down to 15° abs. gives no indication that electronic entropy exists, so that if it were extrapolated on the assumption that no abnormal change would occur at much lower temperatures, the calculation would be in error by 2·2 cal. deg.$^{-1}$ mol^{-1}. The adiabatic change of temperature on magnetization was also measured.

Ionization of Sulphurous Acid

IT is established that sulphurous acid ionizes in two stages: $SO_2 + H_2O \rightleftharpoons H_2SO_3 \rightleftharpoons H^{\cdot} + HSO_3{}'$ $\rightleftharpoons 2H^{\cdot} + SO_3{}''$, and the values of the two dissociation constants have been determined. The first ionization constant has been calculated fairly recently, but with the assumption that the activity coefficient of sulphurous acid is the same as that of hydrochloric acid for the same ionic strength. The second ionization constant had not been determined by a modern method. H. V. Tartar and H. H. Garretson (*J. Amer. Chem. Soc.*, **63**, 808; 1941) have determined both constants by electromotive force methods involving the use of glass electrodes containing suitable buffer solutions. For the first constant the electrolyte was a solution containing sodium chloride and sodium hydrogen sulphite with excess of sulphur dioxide, and for the second dissociation constant the solution contained sodium chloride or bromide, sodium sulphite and sodium hydrogen sulphite, the terminals at each side of the cell being silver and silver halide in both cases. A special investigation of the solubility of silver chloride in sodium sulphite disclosed the existence of the complex ion $Ag(SO_3)_2{}'''$. The values of the thermodynamic dissociation constants at 25° found were: $K_1=1{\cdot}72\times10^{-2}$ and $K_2=6{\cdot}24\times10^{-8}$. The first is in fair agreement with previous determinations by conductivity methods; the second is only in qualitative agreement with other reported values made by much less accurate methods.

Researches on the Meson

THE mesons (mesotrons) found in cosmic radiation are supposed to be capable of spontaneous decay. W. M. Nielsen, C. M. Ryerson, L. W. Nordheim and K. Z. Morgan (*Phys. Rev.*, **59**, 54) have measured the mean lifetime of the meson by comparing the intensity of the hard cosmic rays under a graphite block on top of a mountain with the intensity measured at a lower altitude under an additional layer of atmosphere equivalent in mass to the carbon. The absorption of the mesons in the air and the carbon is the same, and the lower intensity under air is ascribed to the spontaneous decay of the mesons in the time required to traverse the air layer. The calculations of mean lifetime do not depend on assumptions regarding the energy distribution of the particles or the height in the atmosphere at which they are produced. The result obtained is about 1·25 microseconds (for a meson mass 200 electron masses), which is appreciably shorter than previous estimates. Nordheim (*ibid.*, **59**, 554) calculates the ratio of hard and soft component

of the cosmic rays at sea-level, taking this decay period, and considers that the soft component observed is smaller than that calculated on the view that the products of decay are a proton and an electron, and he suggests that some of the energy is carried off by neutrons. F. Rasetti (*ibid.*, 59, 613) has used a coincidence counter system to count occasions on which a meson is absorbed in iron and a shower is emitted after a delay of a few microseconds. This event is supposed to be the stoppage of a meson followed by decay and the emission of an electron which initiates a shower, and an analysis of the delay results indicates that the life of the meson at rest is about 3 microseconds. L. Leprince-Ringuet, S. Gondelsky, E. Nageotti and R. Richard-Foy (*ibid.*, **59**, 460) have analysed a cloud-chamber photograph of a collision between a cosmic ray meson and an electron. The collision took place in a magnetic field, and by good fortune all the track curvatures are suitable for accurate measurement. The mass of the meson is therefore obtainable and the authors estimate it at 240 ± 20 electron masses.

A Neutrino Theory of Stellar Collapse

G. Gamow and M. Schoenberg (*Phys. Rev.*, **59**, 539) have suggested a novel process to account for the appearance of stellar novæ. At the very high temperatures and pressures which exist in the deep interior of a contracting star, nuclear processes may be expected in which neutrons are formed. These particles can escape from the interior without giving up energy, and thus provide a mechanism for cooling the star from the centre. As the centre of the star collapses from this cause, layers just outside the centre are left unsupported and fall in, much gravitational energy being converted into heat. It is shown that the process which takes place involves simultaneously the collapse of the inner layers and the rapid expansion of the outermost layers, with great increase in the luminosity of the star. The process grows more and more violent as the pressure and temperature of the central regions increase. The marked difference between 'novæ' and 'supernovæ' is probably to be ascribed to a difference in mass, since it has previously been shown that a star having less than a certain central mass contracts to a stable configuration of definite radius while bigger stars are subject to unlimited contraction.

The Great Spot on Jupiter in 1939

B. M. PEEK has discussed his twenty-five observations of a dusky spot at the north edge of the South Temperate Belt of Jupiter during July 31–Dec. 21, 1939 (*Mon. Not. Roy. Astro. Soc.*, **101**, 2; 1941). On plotting these observations against the time, they suggested a damped oscillation of some kind, superposed upon a fairly uniform decrease of longitude. Wildt and Peek have shown that the density of Jupiter's atmosphere must increase very rapidly with the depth, unless the internal temperature is high, and it is fairly certain that in the lower strata the gas is practically indistinguishable from a liquid except for the absence of a bounding surface. In his presidential address to the British Astronomical Association (*J. Brit. Ast. Assoc.*, **50**, 2; 1939), Peek expressed the view that masses of light solids which were floating in denser gases might explain some of the surface phenomena of the planet. It is now suggested that the spot observed was associated with the presence of a solid body performing vertical oscillations near the level at which it would have floated in equilibrium. It is possible to derive the density gradient and also the compressibility of the atmosphere at the equilibrium level from the hypothesis. Unfortunately for the hypothesis, the compressibility should be multiplied by a factor 10^7 to make it commensurable with the compressibility of typical fluids.

Dimensions of the Andromeda Nebula

THE great nebula in Andromeda, as seen visually on suitably exposed negatives, can be easily contained in an ellipse measuring $3° \times 1°$. Direct photo-electric measurements made at the focus of the 100-in. telescope at Mt. Wilson have suggested that in reality it extends nearly to $6° \times 1{\cdot}5°$. R. C. Williams and W. A. Hiltner (*Pub. Obs. Univ. Mich.*, **8**, 103; 1941) have recently extended these limits still farther on a long-exposure Mt. Palomar photograph taken with the 18-inch $f/1{\cdot}9$ Schmidt camera. The direct-intensity microphotometer used for tracing isophotes on this negative easily measures a density difference of 0·003, and shows that the apparent diameter along the major axis must be at least 6·7°, corresponding to a real diameter of 80,000 light-years. The surface luminosity at these outer regions is only about 27·8 mag./sec.². The outer isophotes reveal two hitherto unsuspected elongated extensions of the nebula lying on opposite sides of the major axis and suggesting a slight counter-clockwise curvature, though the well-defined inner arms are curved clockwise. This work still further reduces the discrepancy in size between the Andromeda nebula and our own galaxy: we must now regard ourselves as inhabiting a galaxy the dimensions of which, though large, are not of a different order of magnitude from those of neighbouring nebulæ.

Birth Distribution of Sunspots

G. H. A. ARCHENHOLD has constructed a frequency curve of observed first appearances of sunspots (*Mon. Not. Roy. Astro. Soc.*, **101**, 2; 1941). The work is based on Minnaert's method (*Astron. Nach.*, **263**, 13; 1937; also **268**, 81; 1939) with slight modifications. Minnaert's construction gives, for any individual form of life-curves of sunspots, the number of spots which reach the minimum size necessary to be detected in a given interval of longitude. But this theoretical number can only be compared with the one observed at that longitude if the first appearances of sunspots were recorded by continuous observation, and as most statistics are based on daily observations, the first appearances are registered too late—in other words, they are registered in a more westerly position. In addition, spots having a duration of less than 24 hours may completely escape observation. The mean daily synodic motion of a sunspot is 13·2°, for which reason, in the case of daily observations, a spot will be seen somewhere in the interval of 13·2° following the point where it reaches the limit of visibility, and Archenhold adopts this procedure to make the theoretical results comparable with the observations. A full explanation with examples is given. The curve of visibility derived for the Greenwich instruments has been applied, as the results of the investigation are compared with the Greenwich observations. The figure representing the birth distribution shows a very decided correspondence between the theoretical distribution and that observed at Greenwich between 1886 and 1935. It justifies certain assumptions which the author has made on the curve of visibility, on the form and number of the life-curves of spots, and on the intervals in which the observations of the sun are made.

THERMAL EFFECTS IN TRANSFORMATIONS IN METALS

"THERMAL Effects in Transformations in Metals" was the title of a lecture delivered on May 13 by Dr. C. Sykes, superintendent of the Metallurgy Department, National Physical Laboratory, to the London and Home Counties' Branch of the Institute of Physics in the lecture hall of Messrs. Kodak Ltd., Harrow.

Dr. Sykes instanced the change which occurs during the cooling of eutectoid steel as a familiar and typical phase transformation. This transformation from face-centred γ-iron to body-centred α-iron and iron carbide (Fe_3C) has formed the subject of many investigations, and its suitable control has led to important variations being realized in the properties of steel. The temperature at which a transformation takes place has usually been determined from observations on either the direct cooling curve or the inverse-rate curve, or is deduced from the microstructures of samples which have been quenched or slowly cooled from various temperatures. In recent years the limitations of these methods have become apparent. The furnace-cooling methods clearly define the temperature at which a transformation commences, for there the energy released within the specimen causes a definite change in its rate of cooling. This change in rate has but little effect on the cooling of the more massive furnace, and the resultant variation in the difference in temperature between the furnace and the specimen affects the rate of cooling of the latter, so that great care is needed in the interpretation of subsequent results. In the case of β-brass a transformation occurs which commences at about 460° C. and continues down to about 160° C. Transformations of this type require entirely new methods of thermal analysis. Furthermore, since the change consists merely of a rearrangement of the atoms within the solid solution, an examination of the microstructure is no longer helpful.

Little progress was made in the study of such transformations until Tammann observed that they nearly always occur with binary alloys of the types XY and X_3Y. For the body-centred cubic crystal CuZn (β-brass), he suggested that, whereas at high temperatures the atoms are randomly arranged, at low temperatures the copper and zinc atoms are each on separate lattices. Thus, on cooling, heat will be evolved as the atoms settle into the more orderly arrangement. The theory of an ordering process based on similar assumptions to those of Tammann has been worked out by Bragg and Williams. They introduced the quantity s to represent the degree of order of the alloy, and postulate that $s = 1$ corresponds to perfect order and $s = 0$ to complete disorder, that is, the random arrangement. For an XY alloy such as CuZn, it is shown that s can be represented by $\tanh(V/4kT)$, where V, the energy required to interchange a Cu and Zn atom, is not constant but equal to sV_0. These equations have been solved for s as a function of T.

There is shown to be a definite critical temperature, T_c, where the value of s commences to rise steeply from zero and to tend asymptotically to unity at a lower temperature. The X_3Y alloy differs in that s rises from zero to a finite value at T_c and then shows a similar increase towards unity at lower temperatures. It is possible to calculate the energy changes associated with these transformations and so to predict the variation of specific heat with temperature. The transformation should cause the specific heat to exceed the normal value, to rise to a sharp maximum at T_c, and then fall back on to the normal curve. With an alloy of the X_3Y type there should be a definite latent heat at T_c. In the Bragg–Williams theory the average degree of order in the whole crystal has been considered, and a slightly modified result has been obtained by Bethe, who defines order from considerations of the nature of the neighbouring atoms around a given atom of either kind in the structure. Bethe's theory predicts that although superlattice order disappears at the critical temperature, a high degree of local order persists, giving an abnormally high specific heat, which only vanishes at very high temperatures.

At this stage the need for more precise methods for the determination of specific heats over wide ranges of temperature became imperative, and Dr. Sykes was responsible for the development of a method which proved highly satisfactory. The specimen, in the form of a small cylinder fitted with an internal heating coil, is mounted inside a cylindrical copper block from which it is thermally insulated. The whole is inserted in a furnace and can be evacuated. Now suppose the furnace is so controlled that the temperature of the copper block increases at a constant rate, then the temperature of the specimen will rise along a lower curve. If, however, energy is generated in the coil within the specimen, it is possible to bring the temperature of the latter above that of the furnace. At the instant at which their temperatures are the same, no external heat is received by the specimen and so $Q = MC_p(dT/dt)$, where Q is the power supplied to the specimen, C_p its instantaneous specific heat and dT/dt the rate of temperature rise of the specimen. By suitable manipulation of Q, the temperatures of specimen and furnace can frequently be brought into equality and a series of determinations of C_p can be made at increasing temperatures.

Much skill and ingenuity has been used in the development of the apparatus, and the accuracy obtainable is $\pm$ 1 per cent at 400° C. and $\pm$ 2 per cent at 600° C. It has been possible to ensure that the temperature of the specimen does not depart from that of the block by more than 0·1° C. Under these conditions the experiment can be modified to give the total heat content for a specified range of temperature. When this is done, the specimen heater current is passed through a copper voltameter so as to obtain an integrated value of the power supplied.

Detailed experimental results were described for two alloys, CuZn and Cu_3Au. For CuZn the total energy associated with the ordering transformation was found to be 9·8 cal./gm., whereas the Bragg–Williams theory gave 11·4 and the Bethe theory 10·8 cal./gm. Above the critical temperature the specific heat remains abnormally high, owing presumably to the presence of local order.

Further confirmation that β-brass undergoes an order–disorder transformation has been obtained from

X-ray spectrographs. Extra lines, the so-called superlattice lines, have been observed in X-ray photographs of the ordered structure taken with zinc radiation.

Cu_3Au has a face-centred lattice with gold atoms at the corners of each cube and copper atoms at the centre of each face. In this instance it is easy to establish the existence of a superlattice by means of X-ray analysis; in fact, an idea of the completeness of the ordering can be formed from an examination of the intensities of the superlattice lines. The thermal measurements, on the other hand, are somewhat more complicated owing to the slowness with which equilibrium is attained. To overcome this difficulty the following technique had to be adopted. From 420° C. upwards it was found that the specific heat curve was independent of the initial state of the alloy, so presumably it was always in equilibrium at this temperature. The effect of temperature on the energy content was therefore obtained by annealing a specimen at a temperature T until equilibrium was attained and then measuring the energy necessary to heat the alloy from T to 420° C. Since the specimen is in equilibrium both at the beginning and end of the experiment, the energy input to the specimen heater is equal to the difference in equilibrium energy contents corresponding to the initial and final temperatures, although at intermediate temperatures the alloy need not be in equilibrium. The anticipated latent heat is observed and the general agreement with theory is reasonably good, although neither theory gives a correct representation of the release of energy near the critical temperature. The Bragg–Williams theory gives a curve rising too slowly with decreasing temperature, and Peierls's (who has applied Bethe's theory to this alloy) theory gives too great a latent heat.

Other alloys which have been examined are Cu_3Pd and Ni_3Fe, and in both cases fairly good agreement with theory has resulted. Ni_3Fe, which closely resembles mumetal, is of interest in that it has been found that the best magnetic properties are obtained when the alloy is in a state of partial order.

The development of these precise methods of thermal analysis are thus seen to have done much to remove the difficulties which metallurgists have encountered in dealing with order–disorder transformations. R. W. POWELL.

EFFECT OF THE WAR ON BIRD LIFE

By R. S. R. FITTER

RECORDER OF THE ORNITHOLOGICAL SECTION, LONDON NATURAL HISTORY SOCIETY

VERY little is yet known about the effect of the War on bird life in Britain, though the secretary of the British Trust for Ornithology has appealed for information on the subject. It is easy enough to make a number of theoretical deductions from the known variations in ecological and other factors. The decrease of gamekeepers' activity should result in an increase of hawks and owls; the increase of arable and decrease of pasture land is bound to affect the balance of Nature in various ways; the felling of many woodlands will certainly make the woodland birds scarcer after the War; the reduction in the number of oil-discharging boats frequenting the British seas should result in a smaller death-rate among sea-birds; and so on.

A good many scattered records about the actual effect of the War on bird life have appeared in various journals, and should be collated. The present article is based on records sent in to the London Natural History Society during the past year.

Actual casualties among birds appear fortunately to have been very few. A research-worker in the north of England wrote asking to be sent the corpses of any starlings that might be found lying about London after a night of air raid, but though the starlings still come in to roost in London every night, I have not heard of any being killed in an air raid, though doubtless a large number have been. The only definite casualty reported is a missel-thrush killed by a bomb explosion in Hertfordshire. It was found dead thirty yards from where the bomb burst, and there was a wooden fence in between.

Several records have come in of birds taking fright at day-time bomb explosions. The explosion of delayed-action bombs in one area sent a heron screaming over a neighbouring garden, and on another occasion eight crows flew over after a similar explosion. From the same area comes a report that heavy gunfire sends the gulls home to roost early. A barn-owl, on the other hand, has been reported screeching during an anti-aircraft barrage, while a swift was seen circling around quite unperturbed by an air battle going on overhead. A green sandpiper, too, was not driven from its customary roosting-place by the fact that three bombs fell in a neighbouring field, while in two heronries numbers breeding in 1941 were undiminished in spite of many bombs falling in unpleasantly close proximity. Once a wheatear was seen flitting about over the wreckage in one of the worst devastated areas of the East End.

House-sparrows, too, have shown their enterprise. In one suburban town they were quick to explore the new nooks and crannies in a bombed house, and showed a marked partiality for new putty, possibly because of the linseed oil it contained. One result of the bombing of London has been to provide an abundance of potential nesting sites for the black redstarts, which are showing a tendency to colonize London. So far, however, the birds which have appeared in 1941 have favoured only Westminster Abbey, where they bred last year, and the British Museum (Natural History) in South Kensington, where they have been reported in several previous years.

Not many effects of the War on birds' feeding habits were reported, but a large number of black-headed gulls, together with several great and lesser black-backed gulls and carrion crows were seen feasting on the fish apparently killed by bombs falling in the Thames. When two small lakes were drained, black-headed gulls came and cleared the mud of mussels.

The activities of soldiers have had a detrimental effect on bird life in at least one area, where smaller numbers of redstarts and whitethroats are reported to have nested, as a result of military operations, and a cock whinchat disappeared after being alarmed by

soldiers training. No adaptation of nesting habits to war-time changes has been reported that equals the resourcefulness of the sand-martins that nested in a trench dug for military training near Gidea Park Station in 1917.

OBSERVATIONS FOR THE CAPE ASTROGRAPHIC ZONE

THE work which the Royal Observatory, Cape of Good Hope, undertook on the Astrographic Zones − 40° to −52° has been completed and is now available in the volume referred to below*. It was felt that the value of the work would be greatly increased if the spectral types were also given and accordingly these were entered in the copy for the Press from the Henry Draper Catalogue. Owing to the faintness of the stars, however, spectral types were available for only a very limited number, about a quarter of the stars being available.

Dr. Shapley, of Harvard Observatory, agreed that this work was of great importance and the late Miss Cannon undertook the responsibility for it. Unfortunately, the identification of the stars by their Right Ascension and Declination proved too laborious, but the method finally adopted was highly successful. The positions of the stars in a region of the sky photographed by Dr. Shapley having been calculated from rectangular co-ordinates, it was possible by means of the latter to identify the stars on the Astrographic plates by the réseau. It is highly creditable that the spectral types of nearly 90 per cent of the stars were determined and at the same time the spectral types of most of the outstanding stars of the Zone Catalogue. The latter appear as an appendix.

Altogether fifteen tables are given in the volume, and a full explanation accompanies each of these. Under Magnitudes, Table 1 compares the magnitudes in various catalogues with the Cape mean photographic magnitudes. The basis of the system for the "Cape Magnitudes" is explained at the beginning of this section. A sequence of 71 stars from mag. 5 to mag. 12 was selected in the neighbourhood of the South Pole, and an accurate photographic scale was established among these stars by means of a diffraction grating and a series of exposures ranging from 3 sec. to 30 min. The zero point of each plate was based on the Harvard visual magnitude of the brightest star, σ Octantis, mag. 5·48, corrected for the type *F*0. This scale was then transferred to twenty-four Astrographic Regions in declination −45°, each region being photographed on the same plate as the polar sequence.

Other sections, most of which contain one or more tables, deal with star counts, spectral types, mean colour index, faint stars of large proper motion, stars with large proper motion, motion of stars in general, the nearest stars, mean parallaxes. The Catalogue itself is preceded by a brief "Explanation", though the headings of the columns are generally sufficient to explain what follows.

* Catalogue of 20,554 Faint Stars in the Cape Astrographic Zone −40° to −52° for the Equinox of 1900·0 giving Positions, Precessions, Proper Motions and Photographic Magnitudes derived from Photographs taken at the Royal Observatory, Cape of Good Hope, under the direction of Dr. H. Spencer Jones and Dr. J. Jackson; also Spectral Types classified from Plates at the Harvard College Observatory, Cambridge, Mass., U.S.A., by Miss Annie J. Cannon. Pp. lvii+414. (London: H.M. Stationery Office, 1939.) 42*s*. net.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

THURSDAY, JULY 17

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. W. W. C. Topley, F.R.S.: "On the Biology of Epidemics (Croonian Lecture).

FRIDAY, JULY 18

INSTITUTE OF PHYSICS (MANCHESTER BRANCH) (in the Physics Department, University, Manchester), at 7 p.m.—Dr. H. Spencer Jones, F.R.S.: "The 200-inch Instrument".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY DIRECTOR OF EDUCATION—The Director of Education, County Hall, Chichester (July 18).

LECTURER IN MATHEMATICS—The Acting Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (July 19).

HEAD OF THE SCHOOL OF PHARMACY—The Principal, College of Technology and Commerce, Leicester (July 21).

DEMONSTRATOR OF PHYSIOLOGY AND BIOCHEMISTRY—The School Secretary, St. Mary's Hospital Medical School, London, W.2 (July 26).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 122: Specifications and Methods of Analysis for Tar Oil Winter Washes. Pp. iv+22. (London: H.M. Stationery Office.) 6*d*. net. [166

Home Office Circular 807624 (Board of Education Circular 1554): Juvenile Offences. Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [176

The Farmers' Club Library. A Classified List of Books. Pp. 48. (London: The Farmers' Club.) [186

The College of the Pharmaceutical Society. Annual Report of Research Work, 1940. Pp. 30. (London: Pharmaceutical Society.) [196

University of St. Andrews: The Chair of Chemistry in the United College of St. Salvator and St. Leonard. Centenary Lecture, 6th December 1940. By Sir James Colquhoun Irvine. Pp. 27+6 plates. (Edinburgh and London: Oliver and Boyd.) [236

Other Countries

U.S. Department of Agriculture. Farmers' Bulletin No. 1855: Culture, Disease and Pests of the Box Tree. By Freeman Weiss and L. G. Baumhofer. Pp. ii+18. 5 cents. Farmers' Bulletin No. 1861: Insect Pests of the Peach in the Eastern States. By Oliver I. Snapp. Pp. ii+34. 10 cents. Miscellaneous Publication No. 369: The Mineral Composition of Crops with particular reference to the Soils in which they are Grown; a Review and Compilation. By Kenneth C. Beeson. Pp. 164. 20 cents. Technical Bulletin No. 762: Structure and Development of the Alimentary Canal of the Southern Armyworm Larva. By Paul A. Woke. Pp. 30. 5 cents. (Washington, D.C.: Government Printing Office.) [166

Transactions of the San Diego Society of Natural History. Vol. 9, No. 25: The Paleontology and Stratigraphy of the Pleistocene at Signal Hill, Long Beach, California. By James H. DeLong, Jr. Pp. 229–252. Vol. 9, No. 26: A Key to the Pycnogonida of the Pacific Coast of North America. By Joel W. Hedgpeth. Pp. 253–264 (plates 9–11). Vol. 9, No. 27: The Distribution of Pocket Gophers in Southeastern California. By John E. Chattin. Pp. 265–284. Vol. 9, No. 28: A New Chuckwalla from Santa Catalina Island, Gulf of California, Mexico. By Charles E. Shaw. Pp. 285–288. (San Diego, Calif.: San Diego Society of Natural History.) [256

Bernice P. Bishop Museum. Bulletin 161: The Hawaiian Planter. Vol. 1: His Plants, Methods and Area of Cultivation. By E. S. Craighill Handy. Pp. iii+227+8 plates. Bulletin 162: Southern Lau, Fiji; an Ethnography. By Laura Thompson. Pp. iii+228+5 plates. Bulletin 166: Zonitid Snails from Pacific Islands, Parts 3 and 4; 3: Genera other than Microcystinae; 4: Distribution and Indexes. By H. Burrington Baker. Pp. iii+205–370+plates 43–65. Bulletin 168: Oceanic, American Indian and African Myths of Snaring the Sun. By Katharine Luomala. Pp. 58. Bulletin 169: Geology of Borabora, Society Islands. By J. T. Stark and A. L. Howland. Pp. 43+4 plates. (Honolulu: Bernice P. Bishop Museum.) 256

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NATURE

SATURDAY
JULY 19, 1941

ANGLO-AMERICAN COLLABORATION

IN a speech read on his behalf on December 11, Lord Lothian affirmed his belief that the only nucleus round which a stable, peaceful, democratic world could be built after this War was the possession by the United States and Great Britain of air-power, sea-power and key positions superior to those of any possible totalitarian rival. Peace and order always depend on the existence of an overwhelming power behind just law, and more and more people have come to the conclusion that all real hope depends on some form of co-operation between the United States and the British Commonwealth of Nations.

Without some such general realization and indeed actual co-operation, it is almost inconceivable that the British Ambassador in Washington could address the people of the United States so directly, however careful he might be, like Lord Lothian, to state the essential facts and to emphasize the responsibility of his hearers to decide for themselves. The events of the last six months have abundantly justified such frankness and demonstrated the recognition by the two peoples of their common danger and their solidarity in defence of the ideals and heritage which they share. Anglo-American co-operation has become a reality and a dominant factor in the war itself and in the peace and reconstruction to follow. The questions at issue are now those of the extent and form which such co-operation will take.

With the growing scale of America's contribution in the material sphere, there has been a notable contribution in the moral sphere. It is no disparagement of the speeches of Mr. Churchill, of Lord Halifax or of Mr. Eden to say that the major contributions in the statement of the moral issues of the War and its social, economic and spiritual objectives have latterly come from the American side. That might well be expected, but the warmth and sincerity with which they have been welcomed indicates how fully they are shared in Great Britain and how wide and firm is the foundation upon which practical measures of co-operation can be based.

Nor should it be imagined that this affinity of ideals and purpose is limited to leaders. The American Press affords decisive evidence that President Roosevelt, Mr. J. G. Winant and Mr. Wilkie are speaking for, as well as to, their countrymen. American periodicals such as *Fortune* leave their readers in no doubt as to the consequences which flow from the Lease-Lend Act. The probability of a direct collision with Germany is recognized, as well as the opportunity which the acceptance of that challenge would afford the United States to make the international view effective. The decision to fight for international

democracy would indeed not only be a decision to fight for a world in which there was still room for American ideals. It would also be the opportunity to build a new era in which the dualism which has hitherto characterized American foreign relations could be transcended.

Mr. Streit's new book "Union Now with Britain"* bears striking testimony to the startling transformation of American opinion and policy from the consistently isolationist attitude which characterized it during 1919–39. Written as it is primarily and essentially for Americans, it is this changed outlook, sensed or implied rather than directly described, which is the most striking feature of the book in contrast with "Union Now", overshadowing the fact that the intervening two years have witnessed the passage, one by one, under the Nazi heel, of eight of the fifteen democracies for the federation of which he pleaded in "Union Now". The successive fall of these democracies before the same tactics, has brought home to the United States not merely the fuller realization of the ideals and trust for safeguarding man's heritage of freedom which she shares with Great Britain, but also the clear understanding that the choice for her also is between standing now by Britain's side or fighting later and alone in a totalitarian world.

Ostensibly Mr. Streit's new book is concerned with the organization of co-operation, with the development of the most effective machinery for harnessing the resources of the United States and the six democracies of the British Empire to their common task. Fundamentally the book is vibrant with the moral conviction and ideals which have given such force to President Roosevelt's and Mr. J. G. Winant's speeches. The spirit and conviction on which his views are based are irresistible. No nation can live to itself alone. Each nation must give, and he calls on Americans to give fully and with open hands the best they have.

It is on this basis that Mr. Streit pleads for a union of the United States with the six democracies of the British Empire—the United Kingdom, Australia, Canada, Eire, New Zealand and the Union of South Africa—on the lines of the American federal system but with modifications which introduce something of the British parliamentary and Cabinet systems, and starting with a limited union. The working out of a broader and permanent union would be left until later, but the provisional union is intended and planned to be the nucleus of a world federal union to which each western European democracy would be admitted as soon as it is no longer occupied by the forces of dictatorship. Beyond that, the admission of such peoples as the Germans themselves is contemplated when, by ending autocracy at home, they have proved their devotion to democratic principles and their capacity to practise them.

Mr. Streit writes persuasively of the capacity of such a union to win the war as well as to win the peace. From the outset the Union would be prepared to negotiate armistice and peace terms with any Government attacking any territory of the Union on conditions of no indemnities, no reparations, occupations or annexations, and of arbitration of disputes on details. Such an announcement could be used to undermine the totalitarian regimes, encourage revolt and distrust among them and promote the downfall of dictatorship.

Writing eagerly with the moving quality of vivid talk, Mr. Streit rapidly outlines a union programme and discusses alternatives to such a policy. For what he has to say of Anglo-American co-operation there can only be the most cordial assent, and the basic proposal of the creation of a community of principles is inescapable. It is indeed implicit in such speeches as those of Mr. J. G. Winant's to the English-Speaking Union, with its insistence that the common ideals of the English-speaking peoples of this world are not ideals from which other peoples are excluded, on the drawing together of the English-speaking peoples in a struggle to preserve not only their common heritage but also the common ideals of civilized men everywhere, and its firm declaration that this is not Britain's fight alone. The ultimate stakes, the four freedoms of which President Roosevelt has spoken, are the foundation of their common effort, and that the time of action, the hour of decision, has arrived for all who love freedom can no longer be denied.

While the gap between political realities and the vision of Mr. Streit's "Union Now" has been greatly narrowed in the last two years, his argument is less conclusive as to the form which the organization of co-operation should take. It may be possible to demonstrate that had the union existed, the democracies included in Mr. Streit's earlier union would not have fallen. There is, however, no evidence that, even if made earlier and accepted, the offer of union which Great Britain made to France would have averted the fall of France. Federal union alone between Great Britain and France could scarcely have eliminated in time those weaknesses which led to the fall of France, though it might have ensured that the French fleet and French colonies continued the struggle.

On the other hand, as *Fortune* points out, the Lend-Lease Act really constitutes the first crude step in union. By its terms Great Britain and the United States pool such matters as military equipment, production, specification and design, hitherto strictly national. Moreover, the same pool is

* Union Now with Britain. By Clarence K. Streit. Pp. 286. (London: Jonathan Cape, Ltd., 1941.) 7s. 6d. net.

offered and made available to any other country that will take the side of democracy by standing up against Germany. This has been done, however, on the basis of friendship and engagement in a common venture, and that of itself may suggest that, as alternative to federal union, the British Commonwealth of Nations, united by common conventions and understandings about the position and the action of its members, not by virtue of common federal institutions, at least deserves consideration.

It is a mistake to insist too crudely that the choice is between federal union or a formal alliance, as Mr. Streit does, and to reject the latter as bad. It is at least possible that there is a third way, tentative and difficult, but in the end surer and wiser—the experimental way of finding and working out our common understandings and forging the appropriate instruments to serve common purposes. Already we have seen the chastening of nationalism in the British Commonwealth. Given the dynamic outlook and readiness to face change and try new methods, the consciousness of common ideals and traditions which lend Mr. Streit his own inspiration, the same spirit which has worked out effectively the relations between the United Kingdom and the Dominions may work no less harmoniously and effectively between the United States and the British Empire.

To that task must be addressed not idealism alone but also the dispassionate spirit of scientific inquiry, ever advancing step by step as new experiments in co-operation are tried. To such experiments the moral appeal and the rapidly developing world situation give urgency, but it is only on the basis of ascertained facts that Great Britain and the United States can discharge adequately their inescapable responsibilities in peace or in war for the defence of freedom and their common heritage. Whether the first or final stage be union, partnership in some more or less organized form will be required to resolve the conflict between nationalism and trade, industry and culture, and make possible a reconstruction of the world on principles which transcend the national sovereignty that has plunged it into chaos. In such a partnership Great Britain and the United States may well once more attest the truth of Lowell's prophetic words of February 1861, and their manhood make a greater opportunity out of the great danger which they at present share.

FACT AND TRUTH

FROM time to time there flare up echoes of the old controversy between science and religion; not, be it noted in any official form in the sense that leaders of either party take part, but individuals of deep convictions suddenly produce attacks, occasionally in print, which one had hoped were disposed of half a century ago. The fact that such attacks still occur is a reflection on men of science themselves, indicating that they have not yet succeeded in spreading the message of science so widely as they should have done; though it may be in part due to singular obtuseness on the part of their hearers.

The ill-informed have in recent months frequently blamed science for the misuse that has been made of its gifts to mankind, for the developments of the means of waging modern warfare. With that aspect we have often dealt, and we need not go over the ground again. A particularly subtle form of attack on science, however, is to take the line that the facts of science actually have the impermanence of matter, which changes and fades continually, and to contrast them with the truths of religion, which are permanent. Science being based on facts, and the facts relating to it mainly on matter, the argument is, on the face of it, worth examination.

The Oxford Dictionary gives a long definition of *fact*—"thing assumed as basis for inference"; "thing certainly known to have occurred or be true". *True* is defined there as "in accordance with fact". How do these definitions fit in with the outlook of the man of science?

There can be surely no question that the now vast body of scientific workers regard their observations as facts, and also they have a high moral sense of obligation for their pronouncements. As the result of carefully devised experiment, results are obtained which become a basis for inference. These are published for criticism by fellow workers, and if no flaws or omissions are found in the experimental work, they are accepted as facts and form the basis of theories—even of rival theories, a choice between which is only possible when further facts are available. Theories must be altered to fit facts; facts can never be adjusted to fit theories.

In more leisurely days, when a research was published after completion of the work, both facts and theories had been frequently tested during a year or more of investigation, and the final conclusions had a high degree of permanence. When work, however, such as that carried out in the Cavendish Laboratory, is of the greatest international interest, it is desirable to make the

results of the experiments known immediately, it being well understood by colleagues that additional work is in hand. In consequence, there has been a certain amount of correction and withdrawal—what some laymen have called impermanence of facts. This might perhaps have been avoided if publication had been withheld for two or three years, and only the final story told. But the loss would have far outweighed the gain; the individual laboratories would not have been aware of what the others were doing, which experiments to repeat critically, which further developments to pursue or leave to another laboratory. Quick publication has enormously accelerated the rate of progress; the withdrawal of a few errors has been a low price to pay.

Critics unfriendly to science say we 'assert': surely we have a right to do so. The orderly structure of chemistry, based on facts, has enabled us to prophecy with accuracy the existence as well as the chemical and physical properties of undiscovered elements. These were verified when the advancement in experimental technique made the discovery of a new element possible. It is true that the scheme of the elements as originally devised has been proved incomplete; for example, it made no provision for the group of rare gases, present in the air around us, discovered by Rayleigh and Ramsay: this is because for a long time the facts indicating their existence had been overlooked. But the fact—a minute difference in density between samples of nitrogen of different origin—once established, it was followed up until the reason for the difference was shown to be the presence in traces of another gas with very negative properties. Such facts have no impermanence, no relation to doctrinal system.

Another example may be quoted. The organic chemist had used facts to build up a molecular architecture, often of amazing complexity, for carbon compounds, including the natural substances of plants and animals. The chemist was convinced as to the accuracy of this architecture, for he had tested it in so many ways; but it was none the less satisfactory to have these structures confirmed when the Braggs, father and son, developed the technique of X-ray analysis. This, at first confirmatory, has now gone past what the chemist can do, and has established new facts so that we can picture the structure of starch and cellulose, hair and horn.

These are permanent facts, always being added to. The first theories are tentative; new facts strengthen or alter them, but they are always in a state of flux, for theories cannot be permanent though they may endure for a decade or many.

We cannot view the facts of science as impermanent. Doctrinal truths are in quite a different category; their discussion is an individual matter, and no part of our task.

A PHILOSOPHY OF PAIN AND FEAR

Fears may be Liars
By Prof. John A. Ryle. Pp. 96. (London: George Allen and Unwin, Ltd., 1941.) 3*s*. 6*d*. net.

PROF. RYLE's book has, he tells us, been written both for believers and unbelievers to hearten and console men and women in times of trial and trouble. He assures them that pain and fear are natural phenomena; that there is no evidence that they are punishments for our misdeeds: that on the contrary they are conditions not only of the survival but also of the advance of life—without them, it seems, the higher species could not have evolved—and that, so far from being shelved and shunned and enveloped in an atmosphere of mystery, they should be subjected to study and research which show them to be not so very dreadful after all.

Take death, for example. Religion, Prof. Ryle points out, has made death more formidable than it is, terrifying men with the fears of hell and bribing them with the dubious joys of heaven. In fact every death is the beginning of a "peaceful, dreamless night", a nothingness in which we cease to be. Prof. Ryle infers this view of death from the closeness of the mind-body relation. Sensations, emotions, feelings of pain and pleasure are all dependent on the integrity of the nervous system; at death the nervous system disintegrates and our sensational and emotional life, therefore, comes to an end. Possibly; possibly not! The question whether death is the end raises an immense variety of issues and can be approached from a multitude of angles. Of these issues, those that fall within the province of physiology are a small minority; of these angles, that of the medical man only one. For my part, I should have thought that the agnosticism of Socrates' argument—we do wrong to fear death, not because we know that nothing happens after it, but because we do not know whether what happens after (if anything) is better or worse than what happens to us when we are alive; it might just as well be better—was at once more prudent and less dogmatic.

Prof. Ryle proceeds to consider the possibility that it is not death but dying that men fear—death, as a wit remarked, would be all very well, were it not for the dying. But a little research shows that in the great majority of deaths, dying is a comparatively painless process, since coma or shock or hæmorrhage dims consciousness "with a dreaminess or delirium as effective as the precious gifts of the hypodermic needle" and dims, therefore, the consciousness of pain.

But it seems to me that it is not of death nor even of dying that most people are to-day afraid, but of disablement and pain—the being blinded, burnt, infected; the losing of a limb; the being tied for the rest of one's life to a broken and pain-engendering body. This increased sensibility to pain and disablement, this comparative indifference to death is, I suspect, a characteristic of civilized men and women. This is curious, since, as Prof. Ryle frequently observes, there have never been so many devices for the removal of pain; but it is not, I suggest, regrettable. It is a symptom of our demand for life at a higher level than that which sufficed our ancestors (a demand which for some of us has in part and on occasion been realized), a level which is incompatible with disablement or prolonged pain. It is not life *tout court* that we want, but life which can be lived out to the full scope and limit of our faculties. If we cannot have life at this freedom and of this intensity—and we cannot, if we are in continual and recurrent pain—many of us would sooner be without it altogether. I venture to make this point since it enables me to say why I find Prof. Ryle's apologia for pain unconvincing. It is grounded in the demonstration that pain is necessary for survival. If the broken leg did not heal, we should walk on it; if the inflamed tooth did not pain, we should bite on it and so on. In short, "if Nature, or God, had not invented pain, man could not have survived at all". Necessary for survival, pain is also useful for diagnosis. Hence we are bidden not to question Nature's foresight in announcing the presence of disease or "injury by pain".

I find this argument unconvincing. I do not know who or what Nature is, but either She or It has a purpose, or not. If She or It has no purpose, there is nothing and nobody to question. If, however, purpose is to be postulated, it seems to be simpler to go all the way with the religious hypothesis and postulate a Person who conceives the purpose and plans the world which is to fulfil it, in which case the phenomenon of pain assumes a different complexion and requires a different mode of treatment, revealing itself as a particular aspect of the moral problem of evil. Prof. Ryle is precluded from taking this line by his avowed rationalism. But, as a rationalist, what title has he to suppose that Nature or the universe takes any interest in us, benevolent or otherwise, that it *wishes* us to survive and has hit upon pain as a device for enabling us to do so? And why this insistence upon the importance of survival, on life at any cost and on any terms? Even if a man's life were abruptly terminated by accident or maltreatment which, owing to the absence of pain he failed to avoid, when, if he had been sensitive to pain he might have avoided it, why should it be assumed that his life was not worth while, more worth while, perhaps, than a life which was prolonged through pain and in pain? Why not in fact a short life and a painless one?

Prof. Ryle has some interesting things to tell us of fear (also diagnosed as performing a biological function in prompting defensive activity leading to survival) and of pain arising from his recent experiences in attending victims of air raids. The pains of even the worst hit victims are not, it appears, as bad as the layman would be led to suppose, for out of a convoy of twenty or thirty sufferers only two were heard by Prof. Ryle to groan. I am glad to hear it. But I cannot rid myself of the suspicion of occasional special pleading. Prof. Ryle is so determined to make the best of things that he never sees a cloud without looking for, and inevitably finding, the silver lining, with the result that when he means to be consoling, he too often succeeds in being merely complacent.

C. E. M. Joad.

INSECTS AND PLANT DISEASES

Insect Transmission of Plant Diseases
By Prof. Julian Gilbert Leach. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. xviii+615. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 42*s*.

In 1801 it was shown for the first time that bacteria could cause plant disease, and this was only eleven years before the first scientific demonstration of a virus. The discovery that insects were concerned in the transmission of plant disease was made in 1901 when Takami showed that 'dwarf' or 'stunt' of rice was associated with a certain species of leaf-hopper, and at about the same time it was shown that insects could transmit diseases of man and other animals. As early as 1878 Manson had shown that mosquitoes were the

vectors of *Filaria bancrofti*, the nematode causing elephantiasis, and it was Manson, convinced of the importance of mosquitoes as vectors of disease, who stimulated and encouraged Ross in his studies on the transmission of malaria by mosquitoes. The importance of insects in the transmission of the diseases of man has led an increasingly large number of investigators into this field of research. These investigators are trained in the fundamentals of both entomology and medical science. The author of this book pleads for a similar training in the essentials of entomology and botany for potential workers in the field of insect-borne diseases of plants.

Diseases of plants and animals which are associated with insects and allied arthropods fall into a series beginning with that type of disorder which is not due to an agent multiplying within the host, but which is caused by the systemic distribution of a toxin injected by the insect or allied vector. In the plant world there are several examples of this type of disease, such as 'wilt' of pine-apples arising from a diffusible secretion incapable of reproduction injected by a species of mealy bug, and 'psyllid yellows', a disorder of a similar type caused by the potato psylla. This latter disease has all the appearances of a systemic virus disease except that it cannot be transmitted to other healthy potato plants and is not perpetuated by the tuber. A possible parallel in animals is tick paralysis, a condition due to the injection of a toxin by the dog tick. Next in the series come the virus diseases proper, in which an actual disease agent with tremendous powers of self-increase is concerned. In plants this type of disease is in particularly close association with insects and the number of insect-transmitted viruses is very large, curly-top of sugar beet and leaf-roll of potato being cases in point. There are also insect-transmitted viruses affecting man, yellow fever by the mosquito, for example.

The next type of disease is that due to the Rickettsiæ; these are extremely minute agents on the border-line of microscopical visibility which may perhaps be regarded as intermediate between the viruses and the bacteria since they have some characteristics of both. There are many rickettsia diseases of man and animals, the two best known being typhus and its milder cousin, trench fever, both of which are transmitted by the louse. Here also there seems to be a very close association between the disease agent and insects, and Zinsser has suggested that rickettsiæ were originally harmless parasites or symbionts in insects and that the pathogenic forms have developed from these. At all events there occur structures in the cells of many insects which resemble these agents and while no rickettsia diseases of plants are as yet known, similar structures can be demonstrated in phytophagous insects. This makes plain the importance of Chapter iii on insects and their symbionts, which otherwise might have seemed redundant. It is of interest to note in passing that the rickettsiæ of typhus fever become rapidly fatal to the louse itself which suggests that the association between the two is not complete and is of comparatively recent origin. Next in the list of insect-transmitted diseases are those due to undoubted organisms, bacteria, fungi and protozoa. So far as plants are concerned some of all three of these types of organisms are pathogenic and are transmitted by insects. The author himself has done valuable work on the bacterial disease of potato known as 'blackleg' and has shown the connexion between the causal organism and the dipterous maggot which transmits it. One of the most outstanding examples of an insect-transmitted fungus disease known to us is the so-called Dutch elm disease which is spread by the bark beetle, *Scolytus scolytus* Fabr. Examples of plant diseases caused by protozoa which are insect borne are not numerous, though flagellates which pass part of their life in hemipterous insects and part in laticiferous plants are well known.

Prof. Leach deals at length with all the foregoing types of insect-transmitted diseases and gives many examples of each. He devotes two chapters to plant viruses and their insect vectors and gives a comprehensive and up-to-date account of these. In addition to chapters on the actual diseases and the relationships of the transmitting insects, there is a great deal of valuable information on the fundamentals of the general problem. Thus Chapter xii deals with the anatomy and physiology of plants in relation to infection and insect vectors; Chapter xiii describes the anatomy and physiology of insects in relation to the transmission of plant diseases, while Chapter xv describes the feeding and breeding of insects from the same viewpoint. The author casts his net widely, but does so deliberately in furtherance of his plea that investigators in the field of insect-transmitted plant diseases should, like the medical entomologist, be trained in the fundamentals of both the subjects involved.

Prof. Leach is to be heartily congratulated on having brought together in a very readable form such a mass of useful information. There is very little to find fault with in this book, though the reviewer does not quite agree with the statement (p. 278) that "there are very few, if any, true virus diseases [of plants] that are not to some extent transmitted by insects". On the contrary, there are several undoubted viruses which apparently have no connexion with insects; such are the viruses of tomato bushy stunt, tobacco necrosis and potato paracrinkle and, in the reviewer's opinion,

tobacco mosaic virus also. Furthermore, there are about forty virus diseases which spread by unknown means, though no doubt insect vectors for some of these will eventually be found. Probably also the entomologist will not accept the classification of the Homoptera and the Hemiptera into two separate orders (p. 284).

The book is extremely well produced, and the illustrations are excellent. There are carefully selected references at the end of each chapter, and at the end of the book is an appendix giving many salient facts in tabular form. The price is rather high for the average student.

KENNETH M. SMITH.

ULTRA-LIGHT ALLOYS

The Technology of Magnesium and its Alloys
A translation from the German by the Technical Staffs of F. A. Hughes and Co. Ltd., and Magnesium Elektron, Ltd., of "Magnesium und seine Legierungen", compiled by Dr. Adolf Beck. Pp. xxiv+512. (Swinton, near Manchester: F. A. Hughes and Co. Ltd., 1940.) 30s. net.

THE great majority of the technically useful metals crystallize in the cubic system. There are, however, two important ones which have a hexagonal lattice, zinc and magnesium. Though neither of these has a history going back into the distant past, that of magnesium is much the shorter, the metal having been first isolated in 1808. This was about fifteen years before aluminium was isolated, but for various reasons the development of the latter was more rapid; and while aluminium had definitely established its place as an important industrial metal by about 1890, magnesium was only becoming a serious competitor in the neighbourhood of 1910.

The War of 1914–18 saw a great development in the uses of light metals, and the majority of the aluminium alloys at present in use were evolved during that period. Whether new magnesium alloys will be similarly developed during the present conflict remains to be seen: but there can be no doubt that an enormous increase in production must have taken place both in Great Britain and in Germany. This will be obvious to anyone who has been in the neighbourhood of a shower of incendiary bombs.

Many books have been written on aluminium, but apart from a small monograph published in 1937 by H.M. Stationery Office, the volume under review is the first which deals solely with magnesium and its alloys—the 'ultra-light alloys' as the French call them to distinguish them from the 'light alloys' of aluminium. The very marked effect of the anisotropic character imparted to the metal by its hexagonal lattice, and the great influence which this lattice has on the properties of the material, both in mono- and poly-crystalline forms, is very well brought out in the early chapters of the book. Indeed these chapters, dealing with the crystallography, metallography and physical properties of magnesium and its alloys, are probably the best. The one dealing with mechanical properties is very full of specific information, but is, nevertheless, scrappy, as it deals almost entirely with the alloys developed by the German firm with which the authors of the original book were connected—alloys which are, admittedly, the chief ones in use. The translators have had to re-write the first chapter on "Raw Materials" as in the original it presented a view of the situation which was completely biased in favour of Germany, and they have also added many valuable footnotes which help to correct the impression, undoubtedly given by the German edition, that no work has been done on magnesium alloys outside the Reich. The remaining chapters contain much that is of great value to the user of the alloys, whether he is engaged in forming the material into the desired shapes by casting, extruding, machining, etc., or in using the formed shapes in engineering construction.

It is almost certain that a new edition of this most valuable book will be called for some time, if only because of the progress in the subject that will undoubtedly be made during the War. When this is being written the following suggestions may possibly be of assistance. On p. 39 occurs the sentence "some alloys may be etched-down instead of polished". Apart from the ugly construction, the term "etched-down" is not a recognized one, and if it must be used it should be explained. On p. 61 the name Grime is spelled Grimme. On the same page reference is made to the work of Pusîn and Micîc. The authors, in the original paper, called themselves Pušin and Micić. The obvious misprints on pp. 119 and 144 would doubtless be corrected in the new edition. The definition of 'creep' on p. 198 appears very arbitrary and the omission of any reference to general corrosion on p. 273 should be rectified. Table 56 (p. 285) is not at all clear. Probably "pure Mg" should refer to test-piece No. 1 only. A more general point is the conversion of metric units into British ones. Is it necessary, or even advisable to do so, particularly in cases where material has been made to a definite

simple size expressed in centimetres or tested under a load expressed in simple integers when metric units are used ? For example, on p. 159 reference is made to alloys which were submitted to five different stresses of 0, 3·2, 6·3, 9·5 and 12·7 tons per square inch. One naturally wonders why these strange loads were chosen, until one realizes that the stresses actually applied were almost certainly 0, 5, 10, 15 and 20 kgm. per sq. mm.

Finally, but this time a really big request, could not Chapter v ("Mechanical Properties") be re-written on quite a different basis?

Reference has been made above to a new edition. Until this appears this handsome and useful volume is sure to be in constant use by the large number of people who are now so closely connected with ultra-light alloys.

JOHN L. HAUGHTON.

SPECTROSCOPIC METHODS OF ANALYSIS

The Spectrochemical Analysis of Metals and Alloys

By F. Twyman. Pp. viii+355. (London : Charles Griffin and Co., Ltd., 1941.) 21*s*. net.

MORE than a century has elapsed since Fox Talbot laid the foundations of chemical analysis with the spectroscope by his observation that lithia and strontia could be distinguished by optical analysis of their flame spectra. This original idea has proved so fertile that there are now few elements traces of which cannot be identified by their spectra. It is appropriate that Talbot, a notable pioneer in photography, should have initiated a technique which owes so much to the photographic plate. Indeed the development of spectroscopy and its widespread use in present-day industry would not have been possible without the photographic recording medium. Perhaps it is almost equally true that this expansion would not have occurred without the modern spectrograph with its twin virtues of optical excellence and simplicity of operation. Mr. Twyman's contributions to the design and production of such instruments are outstanding and none will question his authority to write a book on spectrochemical methods, more especially as he has maintained close contact with spectroscopists and their technique for more than forty years.

'Spectrochemical analysis' is a compound term which the author adopts in preference to alternatives, such as the ambiguous 'spectrum analysis'. It includes any method of determining the elemental constituents of a substance from its spectrum. The book begins with an excellent historical survey and an elementary account of atomic spectrum theory. Subsequent chapters on instruments and accessories include a very thorough treatment of the microphotometer, an instrument which is of considerable importance for the measurement of line densities on the spectrogram. The major part of the book deals with the quantitative determination of impurities and alloying constituents in metallic samples, but there is a single chapter devoted to analytical techniques for miscellaneous materials including solutions and gases.

It is shown that quantitative analyses can be made swiftly and to sufficient accuracy for a high proportion of metallurgical requirements such as the sorting of scrap, control of alloy compositions, and the checking of purity. The author claims that a minor constituent can be determined to an accuracy of between 2 and 7 per cent, provided certain conditions are fulfilled. Extensive accounts are given of the various techniques in use for the analysis of aluminium and ferrous alloys. Methods are also described for brasses and bronzes, precious metals, lead, magnesium and zinc alloys, and indeed for most of the common metals and alloy groups. The relative scope and merits of alternative methods are carefully assessed, and often their respective advantages have been combined in a standard technique used in the author's laboratory. Practical aspects such as mode of exciting the spectrum, electrode shape and pre-sparking time are treated fully, and in many instances suitable spectral lines for intensity measurement are listed. One slight inconsistency has been noted. Reference is made to the detection of as little as 0·001 per cent of tellurium in a copper globule arc ; this conforms to the reviewer's own experience. Yet twice in the earlier chapters it is indicated that tellurium is not excited in the arc.

References and quotations are abundant throughout the book. The majority of the quotations are usefully included, but a few of them are perhaps too lengthy and are not accompanied by sufficient critical comment for the reader's guidance. The illustrations are adequate, except for a complete absence of photographs of modern apparatus, possibly in view of the author's expressed intention of avoiding reference to the firm with which he is associated. The book is suitably indexed and a bibliography is included, which increases its value

as a work of reference. Units and definitions are also given in an appendix, and it is gratifying to see the logical notation for millimicrons, mμ, used instead of the incorrect $\mu\mu$.

All those engaged on spectrochemical analysis and especially metallurgists will be stimulated by reading Mr. Twyman's up-to-date account of other workers' methods, and they could usefully retain the book for permanent reference. There must also be many responsible for industrial processes who would discover in the method valuable applications to their own problems. The reviewer has not observed any important typographical errors and the quality of binding is well up to the peace time standard associated with the publishers.

L. A. THOMAS.

EPIDEMIOLOGY FOR THE MILLION

Plague on Us

By Geddes Smith. Pp. viii+365+10 plates. (New York: The Commonwealth Fund; London: Oxford University Press, 1941.) 16*s.* net.

THERE are few subjects which tempt 'experts' to write popular books so much as epidemiology; but it would be hard to name a single volume in English which has secured and maintained popularity. At first sight this seems odd; all men are interested in health and disease, the dramatic value of great epidemics is intense and the detective side of epidemiological investigation should appeal to the large reading public which reveres Dr. Thorndyke, Mr. Reginald Fortune and Lord Peter Wimsey. There are many reasons for the lack of success. The possession of a medical qualification, even clinical eminence, does not ensure expert knowledge of epidemiology, while professional *esprit de corps* and an urge to improve the occasion lead to a propagandist treatment. On the other hand, real 'experts' like Creighton (who also had the gift of literary style), *will* hunt hares of their own raising, and the rule Creighton adopted, namely, that whatever was believed by the majority of his medical contemporaries must be wrong, is quite as misleading as simple faith in the infallibility of 'doctors'. Finally, the subject-matter is so vast that an attempt to cover the whole field is threatened on one side by dullness and on the other by sciolism.

Now, when many thousands of men and women are doomed to die of epidemic diseases directly or indirectly due to war, a new appeal to the interest of the many in disease is timely. Dr. Geddes Smith devotes his first chapter to brief but dramatic accounts of great epidemics, or incidents in great epidemics, of the past. To the English reader it is both instructive and interesting that here and in other parts of the book examples are so far as possible drawn from American experience. We tend to be too insular in our epidemiological teaching, and to forget that American epidemiological records cover a much wider field than our own. There follows an excellent account of epidemiological doctrines from the time of Hippocrates to our own days. The next chapter is mainly concerned with the individual biology of infection, the reactions of host and parasite, but the herd aspects as elucidated by Topley, Webster and their respective colleagues are carefully explained, and, in the following chapter, the herd aspects are fully discussed. The next chapter, on defences, necessarily follows beaten tracks, but is refreshingly free from professional dogmatism and over-statement. The following chapter, "Detective Work", tempts me to break the Tenth Commandment; the "Case of the Methodist Ladies" or the "Case of the Sleepy Lobsters" read to schoolboys might do much to awake interest in hygiene. The last chapter, "Unfinished Business", is concerned with the unsolved problems of epidemiology—certainly not less important than those solved. As the author remarks in an epilogue, "The diseases stopped in their tracks by the use of vaccines or antisera are few, and those still unpreventable by such means are many."

In any book covering so wide a field, any specialist will find statements with which he does not agree. The natural predilection of a cobbler for leather inclines me to regret that rather more emphasis has not been put on the importance of the pioneer work of Graunt, Petty and Halley in deflecting interest from speculative opinion to measurable fact. The work of Louis, mentioned in the footnote on p. 55, was directed to show the value of statistical methods in *clinical* research, and, unfortunately, had little effect in Europe. I should have welcomed a critical survey of American developments in this field, particularly as Raymond Pearl and his pupils did much to arouse interest in the analysis of hospital data. But these are matters of secondary importance, and perhaps of little interest to the million. Taken as a whole, this seems to me the best book I have read on the subject, and should do much to raise the level of epidemiological discussion, not only in general, but also in professional circles.

MAJOR GREENWOOD.

An Introduction to the Practice of Organic Chemistry in the Laboratory

By Prof. Homer Adkins, Prof. S. M. McElwain and Prof. M. W. Klein. (International Chemical Series.) Third Edition. Pp. ix+294. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 17*s*. 6*d*.

IN this introduction to the study of organic chemistry, an attempt is made to interest the student in the general principles underlying the experimental work involved in the preparation of fifty carefully chosen compounds by devoting the greater part of the work to the discussion of such general reactions as oxidations and reductions, esterifications and hydrolysis, halogenation, nitration and sulphonation, diazotization, intra-molecular re-arrangements and special reactions including some modern work, and inserting cross-references to the relevant paragraphs to these discussions in the directions for procedure. Relatively little attention is given to qualitative and quantitative analysis, but a few physico-chemical topics such as those involved in the distillation of azeotropic and other mixtures and in extractions with solvents are discussed.

Rules are given for the proper use of note-books, and, since equations and formulæ are deliberately omitted from the experimental directions, the student is expected to make a careful study of each experiment by reference to text-books and to the discussions before beginning the work. At a later stage he is expected to undertake problems involving the use of the library, and a very welcome feature of the book is a chapter devoted to the use of the literature. Some experiments suitable for senior students are included, with references to original memoirs and to standard works of reference. One or two misprints have been noticed and also several mistakes in structural formulæ, but apart from these minor defects the book is likely to stimulate the interest of the novice in organic chemistry.

The Scientific Photographer

By Dr. A. S. C. Lawrence. Pp. x+180+5 plates. (Cambridge: At the University Press, 1941.) 18*s*. net.

IN the preface the author puts in a plea for the more frequent use of photography in the laboratory for the making of permanent records of apparatus and experiments, and for the more extensive use of the lantern slide and cine film for teaching and demonstration purposes. This book is written primarily for the scientific worker who wishes to make use of photography either to augment his own research records or to illustrate his published work; but it is also directed to the serious amateur photographer who, however skilled he may have become by experience, can only benefit by a knowledge of the fundamental principles of photography.

The physicist may find some sections elementary, and in one or two places statements may be found that will scarcely satisfy him. For example, one finds it recorded that the brightness range obtainable in a transparency is greater than that in a print because "the amount of light passing through the high-lights [of the transparency] may be increased at will by increasing the power of the light source".

The book is easy to read and well illustrated, and a great deal has been condensed into its pages. In attempting to cover such a wide field some subjects have inevitably received brief treatment, but the book provides a good groundwork for the thoughtful reader and should give the scientific worker all the information he requires to carry out any normal photographic operations.

Differential and Integral Calculus

By Prof. Ross R. Middlemiss. Pp. x+416. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 17*s*. 6*d*.

THE author of this useful volume touches a vital spot when he says that "while in a first course many students acquire some facility in manipulating calculus symbols, very few obtain a real understanding of the fundamental ideas of the subject". The text has therefore been prepared in order to present the principles and processes of the calculus with special clarity and simplicity without sacrificing accuracy, and there is no doubt that the author has carried out his aim with skill and thoroughness.

Of the twenty-eight chapters, the first thirteen are devoted to functions and their graphs, limits and derivatives. Integration, as the inverse problem of differentiation, then follows and covers the standard forms with many well-chosen practical illustrative examples. The succeeding chapters deal with Duhamel's principle, mean value theorems, centroids, moments of inertia, centres of pressure, partial derivatives, multiple integrals, series, expansion and elementary differential equations. At the end of the text, a handy table of integrals is provided, for reference, together with tables of logarithms, common and Napierian, trigonometric functions, powers, roots, exponential and hyperbolic functions. Large numbers of exercises, with answers, are supplied, which are both interesting and instructive. The text is excellently printed and well illustrated by clear diagrams and isometric drawings. No student who conscientiously works through the course should have any difficulty in reaching a full understanding of the basic principles of the calculus.

Les Chaleurs spécifiques

Par Prof. Edmond Brun. (Collection Armand Colin: Section de physique, No. 224.) Pp. 224. (Paris: Armand Colin, 1940.) 15 francs.

SOME of the books of this series on physical subjects have justly attained an importance out of all proportion to their size. The present volume definitely belongs to this category, for it gives a most admirable survey of the whole field, experimental and theoretical, of specific heat measurements. It is very clearly written, and, as an example, one may mention that a chapter of some twenty-five pages on specific heat anomalies in solids is remarkable for a concise non-mathematical account of order-disorder transformations in metals and alloys. Most students will find it an excellent guide to the study of specific heats.

L. F. B.

FOOD PRODUCTION BY FISH AND OYSTER FARMING

By Dr. F. Gross,
Department of Zoology, University of Edinburgh

History

FISH culture experiments with marine fishes have been made in the past along two lines: (1) Eggs of cod, plaice, turbot and sole have been hatched in hatcheries and the larvæ, prior to the complete absorption of yolk, returned to the sea. In a series of such experiments undertaken by Dannevig for the Scottish Fishery Board, the larvæ were transported to Loch Fyne and released there. (2) Young plaice have been transferred from crowded inshore grounds to richer feeding grounds which were hitherto sparsely populated by plaice.

Hatching operations were undertaken on a large scale in the United States, Norway, Scotland and the Isle of Man, and many millions of larvæ were liberated each year. The results have been much disputed and the statistical data are rather scarce. Fulton[1], discussing the Loch Fyne experiments, came to the conclusion that the liberation of 142,880,000 fry of plaice led to a substantial increase of the plaice population. During the period 1896–1901 when the fry were transferred to Loch Fyne, the average number of young plaice taken with a push net at various points of the Loch was 87·7 per hour, whereas in the second period (1903–1908) when no plaice fry were added, the average number taken per hour was 39·7, or less than half.

The transplantation of young plaice from Danish and Dutch coasts to the Dogger Bank[2,3] in the years 1904–1908 was followed by a remarkable growth of the fishes. The average initial size of the fish transplanted was about 8·75 in.; the average length of the plaice recaptured one year after liberation was 14 in., an increase of 5·25 in. Had they remained on the inshore grounds from which they were taken the annual growth would have been only 2 in. The average growth in weight of the transplanted fish was even more striking, amounting to 382 per cent of the original weight. Similar fish on the inshore grounds only increased their weight by 100 per cent in a year. It is important that, though the growth of the transplanted fish took place most rapidly in the summer months, a certain amount of growth did take place even in winter, when growth on the inshore grounds practically ceases.

Since 1908 the Danes have been transplanting 1–3 millions of plaice annually to the Inner Limfjord. The growth of the transplanted fishes, measuring 16·3–19·1 cm. in length, was very rapid. During one growth period, from April until November, it amounted to 8–13 cm., so that in the autumn most of the transplanted fish weighed about 375 gm. as against an average weight of about 57 gm. on liberation. These figures are taken from Blegvad's report[4] which also summarizes the results of the large Danish experimental transplantation of North Sea plaice to the Belt Sea in 1928–1933. The transplanted fishes showed an increase of 10–12 cm. in length, and 120–490 gm. in weight during the first growth period, which is nearly twice the growth of the local Belt Sea fish. A calculation relating to the transplanted fish of the year 1931 gives the total value of the fish recaptured as amounting to 120,000 Kr., while the actual cost of the transplantation is put at about 40,000 Kr.

Marine Food Resources in War-time

In view of the present difficult food position it would seem desirable to inquire into the possibilities of utilizing to a greater extent the food resources of the sea. For obvious reasons the activity of fishermen is greatly restricted in war-time, the supply of fish is relatively small and the price of this valuable food high. Could we look to an extended practice of fish culture for an increase of the supply of fish? There is no doubt that in areas of water under proper control the culture of freshwater fishes has proved highly profitable. In 1915 Allen[5] compared the yield of organic substance derived from a given area of fresh water, sea water and land, and his figures may be quoted here:

Continental carp pond:	95	lb. of fish per acre per year
Enclosed harbour:	89	,, ,, ,, ,, ,, ,, ,,
Cultivated land:	73	,, ,, beef ,, ,, ,, ,,
Fish from the North Sea:	15	,, ,, fish ,, ,, ,, ,,

Allen then remarked: "The extension of fish culture to marine fishes, which are much more delicate and difficult to rear than those which live in fresh water, is by no means an easy matter, and much further knowledge will be necessary before successful results can be obtained."

Since the time when the various hatcheries began their operations, our knowledge of the sea and of life in the sea, of the life-histories of marine organisms and the conditions governing their growth, has been greatly increased, and a new attempt at the culture of marine fishes would be justified. To succeed in such an attempt marine biologists will have to take counsel of the fresh-water farmer. The large crop taken from a carp pond was the outcome of the application of two sound and simple agricultural principles: (a) an area of land can support a larger population of plants if the soil is properly manured; and (b) if a herd of animals is to be maintained on a piece of land that does not fully provide all the food required by the animals, the diet must be supplemented by some extra feeding-stuff. True to these principles the carp ponds receive a copious supply of stable manure drained direct into the pond, and fish meal is added to supplement the food provided by the intensive growth of the vegetation and the fauna of the pond as a result of the manuring.

The marine hatcheries which have returned to the sea millions of fish fry in a most helpless and delicate stage have, in a way, attempted to get something for nothing. They expected a richer harvest merely by increasing the number of seeds sown. It is true that the protection afforded during their embryonic development and part of their larval life may result in the survival of a number of larvæ liberated. But this number cannot be substantial; there is no food for a surplus population of larvæ belonging to an indigenous species. As it takes roughly six million eggs to give two turbot a chance of reaching maturity, it is probable that the release into the sea of the larvæ will also result in the destruction of the vast majority owing to the severe competition under natural conditions.

The liberation of large numbers of larvæ in Loch Fyne was a hazard. As it turned out, the experiment was successful to a degree, leading to a certain increase of the plaice population. It was a hazardous undertaking as, so far as I know, no survey of the plankton and the bottom fauna on which the plaice depend for food had been made prior to the 'planting' of the larvæ. Loch Fyne had a plaice population of its own which naturally did its best to grow in numbers. As no steps had been taken to increase the food supply for the greatly increased larval population, only a mere fraction of the 142,000,000 fry was given a chance to survive.

It is common knowledge that animal life in the sea depends to a large extent on the phytoplankton for its supply of organic food, and it seems obvious that the bulk of animals maintained is roughly proportional to the bulk of the vegetation on which they directly or indirectly graze. It is significant that Allen, in the address referred to, said that his work on the artificial culture of plankton diatoms was commenced "largely with a view to obtaining information about some of the fundamental problems upon which any scientific practice of fish culture would need to be based". Further work has brought a fuller understanding of the different factors favouring and limiting the growth of phytoplankton in the sea.

Cultures of quite a number of species of plankton diatoms and autotrophic flagellates can be maintained in the laboratory throughout the year [6,7], each subculture reaching a density of population many times greater than in the sea. During the spring outburst the number of diatom cells may reach a maximum of about 50,000 per litre in the sea[8]. In Loch Striven as many as 25,000,000 cells per litre are present for a short period during the spring increase[9]. In a culture, 500,000,000 cells per litre may be reared at all seasons, provided the culture medium is properly enriched with nutrients required for their growth, namely nitrate, phosphate and soil extract, containing substances the action of which, though not yet fully understood, is highly beneficial for the growth of marine organisms.

Attempts to culture plankton organisms on a larger scale in the 'plankton shaft' of the Oceanographic Institute in Göteborg gave encouraging results[10,11]. In spite of the detrimental effect of convection currents, by which large numbers of diatoms were carried to the cooling pipes and immobilized there, the phytoplankton reached a population density larger than in the sea during the spring increase, namely, 660,000 diatom cells and many more autotrophic nannoplankton flagellates per litre. In a separate experiment, the density of the zooplankton population, consisting chiefly of copepods, that could be supported in the plankton shaft for more than three weeks was at least of the same order of magnitude as that occurring in the sea. Had it not been for some technical faults of the shaft it would probably have been considerably larger, particularly if diatoms as well as flagellates had been provided as food for the copepods.

We may now make certain proposals regarding the methods for the future culturing of marine fishes and oysters. It is essential that areas of water be chosen which can be to some extent controlled, that is, manured and stocked, if necessary, with organisms forming the food chain on which the fishes depend. Only artificial ponds, harbours and lochs connected with the sea by a mouth sufficiently narrow to prevent a rapid mixing of the water with the sea outside could be used for the purposes outlined below, and only

those fishes which show little tendency towards migration before maturity, for example, dab, plaice, turbot, sole and flounder, could be thus 'farmed'.

(1) FATTENING OF SMALL FLAT FISHES

It would be relatively easy to collect large numbers of flat fishes below marketable size, say 5 in., and transplant them into the chosen area which, analogous to the carp pond, would provide the conditions for rapid growth. The water would be manured with nitrate and phosphate, which, as we know, represent two of those 'limiting factors' that control the seasonal waxing and waning of the phytoplankton population. Other substances which are present in the sea in small exhaustible quantities and are required by the micro-vegetation would be provided by slow-acting fish meal manure and farmyard manure, if available, and by soil drained into the water. Thus the conditions would be created for a rich and prolonged production of phytoplankton. We cannot predict what kinds of organisms would respond best to the conditions provided; but there are probably few, if any, kinds that would not be utilized either as larval food or as food of the bottom fauna.

The great bulk of planktonic forms, and also the sedentary polychætes and lamellibranchs which form the chief items of the diet of flat fishes, are particle feeders, and are not very particular as to the kind of autotrophic organisms they filter into their digestive system. *Calanus finmarchicus*, for example, can utilize quite a range of organisms, from the most minute flagellates (2μ in length) to relatively large diatoms such as *Ditylum Brightwelli* reaching a size of 80μ by 100μ [12]. On the other hand, detritus should be a good source of food supply for the bottom fauna from whatever kind of phytoplankton it may have originated.

We may assume that under such conditions the local population of bivalves and polychætes would thrive and increase. If necessary, the stock could be augmented by the transplantation of large numbers of molluscs and polychætes from the sea-shore, and thus an ample food supply provided for a large fish population all the year round. The conditions for the growth of the fishes would then be at least as favourable as on the Dogger Bank or in the Limfjord, and the rate of their growth at least as high. That would mean that transplanted fishes of 120 gm. should reach marketable size—1 lb. in weight—in one year or even less. An annual increase in weight of 400 per cent may well be expected in view of Ben Dawes's investigations on the growth and maintenance of plaice[13] in which increases in weight of fishes ranging from 340 to 580 per cent and more were obtained during a period of 175 days.

(2) REARING OF FLAT FISHES

It was realized by Dannevig[14] that the advantage of fish culture would be much greater if the protection given to the eggs by the hatcheries during the embryonic development could be extended through the period of post-larval development until the time the flat fish lives on the bottom. The hatcheries did not rear the larvæ beyond the stage of yolk absorption because of the 'critical period', that is, one of very high death-rate, following that stage.

However, Dannevig was able to rear a small number of plaice without very much trouble, and a few specimens reached an average size of 3·25 in. in about nine months. Preliminary experiments with eggs of plaice, undertaken recently by me in collaboration with Mr. J. Raymont, show that after the absorption of the yolk the larvæ fed very actively on diatoms for about a week, and the death-rate during this period is negligible. In these experiments the stage after the complete absorption of the yolk was 'critical' and this only because the next link in the food chain, namely, crustacean or mollusc larvæ, could not then be provided. Rollefsen[15] reports in a preliminary communication that artificially hatched plaice and flounder fry could be successfully reared up to the bottom stage on a large scale by feeding with nauplii of Artemia. In our experiments the plaice larvæ did not take to feeding on Artemia nauplii, possibly because of their relatively large size* and attempts will be made in future experiments to bridge over the gap with small harpacticoids and cyclopoids which, like Artemia, are being cultured on a large scale in this Department.

Dannevig was probably justified in arguing that as rearing on a small scale is possible, it would be easier to rear larval fish in a large enclosure. "The success of such an experiment would mean that such valuable fishes as the sole and turbot could be protected in captivity throughout the time of the early development while the enormous destruction takes place in the sea."

However, even when planted out or kept on in enclosures after metamorphosis, great destruction would take place among the flat fishes, chiefly by cannibalism, and the growth of the fish would be very slow, unless the natural food supply of the area was increased. Growth depends on the

* The stock used for our cultures originated from an Italian polyploid parthenogenetic race[16].

density of the stock; great density entails less food per fish and therefore slower growth. If, however, the rearing of the larvæ were done in enclosures farmed in the proper manner, one might expect survival and rapid growth of a large proportion of small fishes, which after two years' intensive feeding might reach marketable size.

(3) OYSTER CULTURE

Recent experiments by Cole[17] in Conway and by Bruce, Knight and Parke[18] in Port Erin, show that by employing the culture methods for phytoplankton organisms, developed by me some years ago in Plymouth, and by feeding oyster larvæ with some of my cultures of minute flagellates a large settlement of oyster larvæ can be obtained. The procedure adopted in Conway is to let the larvæ settle on tiles placed in tanks and to transplant them afterwards to cages planted in the Menai Straits where growth takes place at a very satisfactory rate.

It is suggested that this work be extended by transplanting the settled spat to enclosed areas of water with a larger food supply than is available under natural conditions. The method may be further modified by allowing the larvæ to settle on pieces of rope and either to attach the ropes to poles stuck in shallow parts of the enclosure, as has been the practice of some oyster breeders in France and Yugoslavia, or to suspend the ropes on rafts floating at the surface.

These three types of experiments, quite apart from their economic potentialities, should yield results of great scientific interest. They would give us the first indications of the reaction of a large, but relatively isolated marine community to environmental changes brought about purposely by man; they would show how the intricate network of factors responsible for such phenomena as the seasonal sequence of plant and animal associations, their growth and decline, and the competition among the various species, would alter in quality and intensity under the impact of an 'agricultural' improvement of their ecological realm.

As to the localities where such experiments could be undertaken, their choice will depend largely on the scale on which they are to be attempted. I have consulted Mr. Elmhirst, Dr. Marshall and Dr. Orr of the Marine Station in Millport on this point and have discussed the whole scheme with them, receiving much encouragement from them. There are quite a number of lochs in Scotland which might be very suitable for pisciculture. Some lochs would probably require the damming up of their sea entrances, while, on the other hand, others could be farmed without damming.

To test the validity of the methods outlined above a preliminary investigation would seem desirable. For this purpose Loch Sween is perhaps suited best owing to the existence of three or more basins with entrances only 4–10 yards in width, which could be easily dammed up and used for the fattening and rearing of fishes and oysters. Dr. Orr informed me that the sand there, although muddier than in the open Clyde area, is probably quite suitable for young plaice. There are very numerous lug-worm casts, and mussels and cockles are abundant. In the branch of the loch called Linne Mhurich there are numerous shells of large oysters and Dr. Orr was told that there were still some oysters lifted each year in this branch. It therefore would be highly suitable for oyster culture.

Should the preliminary experiment prove successful, fish and oyster farming could be developed on a sufficiently large basis to add considerably to Great Britain's home-grown food supply. However, at present, the problem is to find the means for financing the preliminary experiments. A rough estimate made with the kind help of Prof. J. Ritchie puts the expenditure at about £3,000 for damming, compensation to owners, catching and transportation of young fish, etc. On the other hand at least 120,000 young fish would be transplanted for fattening, weighing approximately ¼ lb. each. A catch of 60,000 fish of 1 lb. at 1*s*. per lb. after one year would repay expenditure, of which the biggest items (damming and compensation) would not recur in the following year. Admittedly no such experiments have been made so far, and there is a certain risk that the project might not be altogether profitable as a commercial undertaking. This much can however be said: we have sufficient experience—from transplantations and culture experiments in particular—to plan it with a reasonably good chance of success.

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ABSORPTION SPECTRA OF HÆMOGLOBIN IN SOLUTION AND IN RED BLOOD CORPUSCLES

By Prof. D. Keilin, F.R.S., and Dr. E. F. Hartree
Molteno Institute, University of Cambridge

IN 1877 and 1879 Hoppe-Seyler[1,2] put forward the theory that the hæmoglobin within the red blood corpuscles is not identical with that which appears in solution after lysis of the corpuscles. He even proposed for the intracorpuscular states of the pigments in arteries and veins the names 'arterin' and 'phlebin', reserving the names oxyhæmoglobin and hæmoglobin for the corresponding pigments in solution. However, the numerous arguments brought forward by him in support of this theory were soon invalidated by other workers, who found an easy explanation of all his observations without postulating the above theory[3]. Hoppe-Seyler's theory was soon abandoned, and considered until recently as of purely historical interest. It was, however, recently revived in a slightly different form with fresh evidence in support of it.

It is well known, since the classical work of Soret, that the absorption spectra of hæmoglobin and all its derivatives down to the porphyrin show, in addition to the absorption bands in the visible region, a strong and sharp band near the violet end of the spectrum between 405 mμ and 430 mμ. This band, which is much stronger than the other bands of these pigments, is known as the Soret band or γ-band. It is absent in all derivatives with an open pyrrol chain such as bile pigments or even compounds like verdohæmochromogen with an open tetrapyrrolic chain maintained in ring form by the central iron atom[4].

It was shown recently by Macallum and Bradley[5] (1930) and Adams, Bradley and Macallum[6] that the γ-band is absent in oxyhæmoglobin of intact corpuscles although it appears at once on hæmolysis. This observation seems to suggest that there must be some physical or chemical difference between hæmoglobin inside and outside red blood corpuscles. The problem was reinvestigated by Adams[7], who made an attempt to determine the nature of intracorpuscular hæmoglobin which could account for the disappearance of the γ-band. The main conclusion of his study is that within the corpuscle hæmoglobin is not free but forms with the 'stromatin' of the corpuscle a compound devoid of band γ. This compound appears to be very labile and rapidly dissociates, even on ordinary lysis, liberating the hæmoglobin which shows the normal band γ. This view is based on experiments *in vitro* which seem to show that hæmoglobin, when mixed with a solution of stromatin, brought to *p*H 9·7 and warmed for about 1hr. at 37° C., gradually loses its absorption band γ. It cannot be disputed that the problem as to the state of hæmoglobin within the corpuscles is of great physiological and biochemical interest. It is therefore a matter for some surprise that this phenomenon of obliteration of the γ-band discovered in 1930 has not stimulated more work in other laboratories. We should like to mention that although a quartz spectrograph as was used by the above workers is the best instrument for the quantitative study of this problem, the main optical phenomena can be observed and studied by means of much simpler spectroscopic apparatus more easily accessible to less specialized laboratories. We shall briefly describe the three spectroscopic methods used by us.

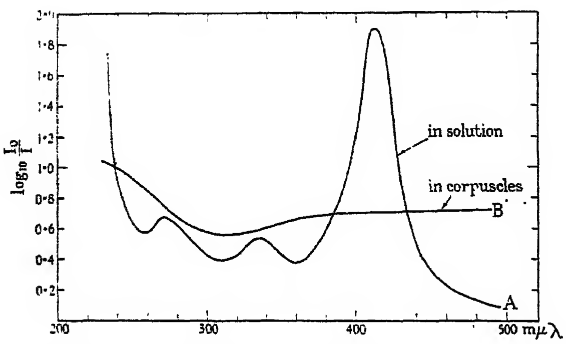
(1) Spectrophotometric method using Hilger quartz Spekker photometer.

(2) Fluorescent method. For this purpose light from 500 c.p. Pointolite lamp is focused on the slit of an ordinary constant deviation spectroscope. The eye-piece of the latter is removed and the emergent spectrum focused by means of lenses on to a glass cell (2 mm. thick) containing a fluorescent solution such as (*a*) 1 per cent solution of 3 : 6-dihydroxyphthalonitrile in 70 per cent alcohol and 0·2 per cent sodium carbonate, or (*b*) 1 per cent solution of 7-aminoquinaldine, in 70 per cent alcohol containing 0·1 per cent sulphuric acid. Using glass throughout, the spectrum extended down to about 360 mμ. The cells containing the absorbing solutions are placed between the spectroscope and the fluorescent cell.

Replacing the Pointolite by a mercury-vapour lamp enabled the apparatus to be calibrated. The drum of the spectroscope was set at 435·8 mμ and a pointer attached to the fluorescent screen to mark the position of the corresponding emission band. The wave-length of the absorption bands could then be determined by bringing them to the position marked by the pointer and reading the drum.

(3) The third method, which is the direct spectroscopic observation of the γ-band, is possible only for CO-hæmoglobin and desoxygenated hæmoglobin, the γ-bands of which are at 420 mμ and 430 mμ respectively. These two bands can easily

be observed with an ordinary microspectroscope ocular attached to a microscope and a strong light passing through a suitable filter such as copper sulphate solution combined with either a solution of ammoniacal copper sulphate or a Wratten filter *D*. This method, owing to its simplicity, was finally adopted for rapid spectroscopic examinations of hæmoglobin in red blood corpuscles and in solution. For this purpose 2 ml. of a dilute suspension of washed blood corpuscle in isotonic saline is placed in a Thunberg tube, and 0·2 ml. of a dilute solution of saponin is put into its hollow stopper. The tube is either evacuated and filled with carbon monoxide or boiled in a vacuum until the oxyhæmoglobin becomes completely desoxygenated. The content of the tube is then examined spectroscopically in a strong beam of



Absorption spectra of oxyhæmoglobin in solution and in corpuscles using Spekker U.V. photometer.

Curve A, 1 part washed blood cells in 2,500 parts water. Water in compensating cell.

Curve B, 1 part washed blood cells laked in 2,500 parts normal saline. Compensating cell contains a suspension of yeast in saline of approximately equal turbidity. The yeast suspension was matched nephelometrically in red light with the corpuscle suspension.

The values of the absorption coefficient are not absolute but are the readings obtained directly from the photographic plate using 20 mm. cells.

light passing through the coloured filters. Neither CO-hæmoglobin nor reduced hæmoglobin show any indication of the band γ before laking. On mixing the contents of the tube and the stopper the corpuscles are laked and the CO- or reduced hæmoglobin passes into solution.

Spectroscopic examination of the solution now reveals a very strong γ-band lying at 420 mμ or 430 mμ respectively. Similar results were obtained in experiments carried out by the first two methods. The second method, although comparatively simple and not requiring expensive instruments, enables the direct observation of the bands to be carried out much farther into the short wave end of the spectrum, which makes possible the study of all derivatives of hæmoglobin. The first method has the advantages of being quantitative and giving a permanent record of the experiment (see accompanying graph).

While reduced, oxygenated and carbon monoxide hæmoglobin are easily obtained within intact corpuscles, their conversion into methæmoglobin requires somewhat more complicated manipulations. The method adopted was as follows: 20 ml. corpuscles in saline are shaken with 20 ml. 1·06 per cent sodium nitrite in a 200 ml. centrifuge tube. After 5 minutes the tube is filled with 0·9 per cent sodium chloride, well mixed and centrifuged. The residue is then washed three times with normal saline. The methæmoglobin in the corpuscles can easily be transformed into the acid form by suspending them in 0·154 *M* KH_2PO_4.

All these experiments confirm and extend the results obtained by previous workers[6], namely that the very strong Soret or γ-band in the absorption spectrum of Hb, O_2Hb, COHb or metHb in solutions is scarcely perceptible or completely invisible in these pigments within the intact corpuscles.

We have also attempted to repeat the experiments to which we have previously referred and which according to Adams seem to prove the formation of a compound between hæmoglobin and stromatin.

For this purpose stromatin was prepared by two methods, that of Jorpes[8] and a somewhat simpler method which we have previously used for the purification of hæmoglobin[9]. According to this latter method 300 ml. of fresh horse blood corpuscles are cooled to 0°C. and laked with 90 ml. of cold distilled water and 90 ml. of cold pure ether. The mixture is shaken for five minutes, mixed with 30 gm. sodium chloride and centrifuged. The centrifuge tube contains two distinct layers, a thick almost solid layer of red stroma on the top and a clear, strong solution of hæmoglobin underneath. The centrifuge tube is slightly tilted, so that the clear hæmoglobin solution can be sucked off. The stroma are mixed with ice-cold water, thoroughly shaken, and centrifuged. This manipulation is repeated several times until most of the hæmoglobin is washed out.

Numerous attempts to combine hæmoglobin with stromatin, carried out under different conditions including those described by Adams, failed, however, to reveal any evidence for the existence of such a compound.

In all our experiments the γ-band of hæmoglobin remained strong and clearly visible, which is not surprising considering that this band belongs to all hæmoglobin derivatives containing a closed tetrapyrrolic ring. In fact it is present in porphyrin, hæmatin, hæmochromogen, parahæmatin, hæmoglobin, O_2Hb, COHb, metHb

and the compounds of the latter with H_2S, H_2O_2, NaN_3, NaF and NO.

In other words, even if the existence of the supposed hæmoglobin-stromatin compound is accepted, it could scarcely be expected that the absorption spectrum of such a compound would be devoid of the γ-band.

The absence of the γ-band in the suspension of intact red blood corpuscles, while it is present in a suspension of oxyhæmoglobin crystals or in an amorphous precipitate of hæmoglobin, excludes any simple optical explanation of this phenomenon.

Attempts were made to imitate a suspension of corpuscles by suspending droplets of concentrated oxyhæmoglobin solution in oil. For this purpose 0·1 c.c. of strong oxyhæmoglobin solution (containing 0·3 mgm. Fe per ml.) is shaken with 50 c.c. medicinal paraffin containing 0·02 per cent sulphonated castor oil. The mixture forms a permanent suspension of very fine droplets of hæmoglobin solution varying from 7μ to 14μ in diameter. Spectroscopic examination of this suspension shows that while the strength of the bands α and β is at least 80 per cent of that of the original solution, the band γ is completely invisible. A suspension in pure castor oil has similar properties. On centrifuging the suspension with a little water, about 75 per cent of unmodified hæmoglobin can be recovered. On the other hand, if oil droplets are dispersed in a dilute solution of hæmoglobin, all absorption bands of the emulsion are of the same intensity as the corresponding bands in the solution of hæmoglobin of similar concentration. That the depression of the band γ of hæmoglobin dispersed in oils is not due to the effect of the dispersion on the protein is shown by the fact that a similar disappearance of the band in the violet can be noted in a solution of acid porphyrin dispersed in castor oil.

All these experiments clearly show that the failure to observe the band γ of hæmoglobin when this pigment is within red blood corpuscles must be due to a purely optical phenomenon brought into play by the properties of surfaces separating hæmoglobin from the surrounding medium. At present we are unable to offer a simple optical explanation of the mechanism of this phenomenon either in the suspension of the red corpuscles or in the emulsions of oxyhæmoglobin in oils.

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OBITUARIES

Prof. R. Robison, F.R.S.

THE Lister Institute has sustained a severe loss to its active strength by the sudden death on June 18 of the head of its Biochemical Department, Prof. Robert Robison. He was in his fifty-eighth year. On the previous day he was at work as usual in the Institute and was looking forward eagerly to spending a brief respite from duty at his home in Putney and tending his beautiful garden. Thus has been cut short a career of strenuous endeavour and high accomplishment in biochemistry, which is the poorer for his loss.

In 1913 Robison was appointed second research assistant to Arthur Harden in succession to W. J. Young, who had migrated to Australia and is now professor of biochemistry in the University of Melbourne. He came with the strongest credentials to his chemical training and research experience acquired at the University Colleges of Nottingham and Galway and the University of Leipzig. The War of 1914–18, during which he served in Italy and the Middle East as a captain, R.A.M.C., engaged in sanitary duties, broke the progress of his early researches at the Lister Institute; but one piece of work which Harden and he published in 1914 and which bore the title "On a New Phosphoric Ester Obtained with the Aid of Yeast Juice" was destined to presage the field of study to which, in post-war years, Robison was to devote his whole energies and which in one extension or another held his interest to the end.

It was not until 1921 that Robison was able to return to the subject of his life work, for in the immediate post-war years he had helped Harden with his investigation of the antiscorbutic properties of fruit juices and had collaborated with C. J. Martin in a valuable study of the minimum nitrogen expenditure of man and the biological value of proteins for human nutrition, a study which involved for both the strictest regimen of prescribed and uninteresting diets over considerable periods. In 1922 appeared Robison's report of the separation and purification of the hexosemonophosphoric ester, which he and Harden had found among the fermentation products of sugar by yeast juice, and it was followed in 1923 by the first of what was to prove a lengthy series of papers devoted to the carbohydrate-phosphoric esters and their physiological roles. In this first

paper he tells us how the appearance of a calcium phosphate precipitate in the hydrolysis by enzymes of the hexosemonophosphoric ester suggested to him the possibility that some enzyme might be found in the growing bones of animals which could effect the deposition of calcium phosphate and so lead to bone formation. Such an enzyme Robison found in the hypertrophic ossifying cartilage of young rats and rabbits, and so began that series of studies on the significance of the hexosephosphoric esters in ossification and in metabolism generally which, with the help of a succession of collaborators including H. D. Kay, K. M. Soames, M. Martland, Morna Macleod, E. J. King, Honor Fell, A. H. Rosenheim, M. G. Macfarlane and W. T. J. Morgan, he devoted the twenty years of life that remained to him.

In 1930 Robison was elected fellow of the Royal Society, and in 1931 he was invited to deliver the Herter Lectures in New York on the subject of his work. In January 1931 he became head of the Biochemical Department on Harden's retirement, and about the same time the University of London conferred upon him the title of professor of biochemistry. In 1933 the Royal College of Physicians honoured him by the award of the Baly Medal, a tribute he greatly valued.

Than Robison there was never a more conscientious head of a research department. Helpfulness was his keynote and an insistence at all costs on honest and accurate performance. No pains were spared, sometimes unfortunately at the cost of a constitution that was never too robust, to make the sojourn of workers in his department, whether native or foreign, both pleasant and profitable. To offices that outside bodies called upon him to perform —and they were many—he gave ever the most serious attention, and indeed his presence where chemists and biochemists foregather will be greatly missed, for he was a man of wide and cultured outlook and strongly held convictions. He leaves a widow and a married daughter, trained in her father's science, and to them we would offer our sincere sympathy.

J. C. G. LEDINGHAM.

Sir Edward Blunt, K.C.I.E., O.B.E.

SIR EDWARD BLUNT, whose death occurred on May 29, was born in 1877, educated at Marlborough and at Corpus Christi College, Oxford, and entered the Indian Civil Service in 1901. He was superintendent of Census Operations in the United Provinces of Agra and Oudh for the census of 1911. It was in that capacity, when Sir Edward Gait was census commissioner for India, that Blunt undertook the study of caste and the social structure of Hinduism, the results of which appeared in his census report published in 1912. It contains a critical examination of Hinduism as observed by him in the United Provinces, and the subject of caste, though treated there in a separate chapter, is primarily approached from its aspect as an essential element of Hinduism, which "depends a great deal more on whom one marries and what one eats and drinks, than on what one believes". The tenets of Hindu sects are also examined, and it is interesting to observe that the *Arya Samaj* is treated as a different religious unit from Hinduism proper. In 1891 the *Arya Samaj* had demanded separate classification, but the position had so far changed by 1911 that to meet various objections Blunt then classified them as *Hindu Arya*, though as an entity independent of *Hindu Brahmanic*. This arrangement had to be altered in subsequent censuses, which included the *Arya Samaj* as a mere subhead of the Hindu total.

Blunt treats caste as the result of a cross-division of guilds on a class system based on colour, on which as involving hypergamy he lays particular stress. The origin and nature of sub-castes he also dealt with, aptly illustrating the position by the Laungbarsa sub-caste of the Dhanuk caste, which in one place is strictly endogamous, in another in the same district strictly exogamous, and in yet a third exogamous as regards one other sub-caste of Dhanuk but endogamous as regards all others. Further, wherever it is exogamous it sometimes only gives girls to, sometimes only takes them from, the same sub-caste of Dhanuk. In investigating civil conditions, Blunt contributed much information on survivals of the levirate in various castes of the United Provinces, as well as comprehensive lists of the terms of relationship and a brief but very useful examination of Hindu exogamy in general.

"The Caste System of Northern India", published in 1931, covers a good deal of the same ground as the Census Report, though there is much added material such as the important chapter on "Caste and Islam". The book, however, is in one respect out of date for a book of 1931 in that it retains Risley's dogma of the civilized Aryan invader and the primitive savage Dravidian. It seems now much more probable, in view of subsequent researches, that the Dravidian-speaking population was more advanced in the apparatus of civilized life than were the Rigvedic invaders, and that the stories of contest between the enlightened invader and the black and noseless Dasyu were derived from the traditional inheritance of pre-Rigvedic inhabitants. Moreover, Stanley Rice's cogent correlation of caste with taboo suggests a much earlier origin for that system than Blunt envisages, though he specifically avoided dogmatizing. Sir Edward Blunt's researches, however, though they may not embody the latest ideas as to the origins of caste, have provided us with one of the best of the very few recent books which describe the facts of caste, and with much valuable material for its understanding; on the score of this he has earned a definite and important position among the distinguished students of that unique phenomenon.

J. H. HUTTON.

We regret to announce the following deaths:

Sir Arthur Evans, F.R.S., honorary keeper of the Ashmolean Museum in the University of Oxford, the leading British authority in the classical archæological studies, on July 11, aged ninety (see also NATURE of July 12, p. 46).

Sir William Willcox, medical adviser to the Home Office since 1919, on July 8.

NEWS AND VIEWS

Soviet Men of Science and the War

FOR the second time in twenty-five years the whole world is plunged into war; and already it has brought death to hundreds of thousands and disaster and unhappiness to millions. Prof. P. Kapitza, in a broadcast from Moscow on July 6, said that he was speaking in particular to British men of science and intellectuals and he reminded them that he had worked for some time in Cambridge under Lord Rutherford where he made numerous friends and carried away many pleasant memories. He wished to discuss the relations of the War to science and culture. The attitude of Fascism to science is that of a woodcutter who uses his axe to disable people instead of to cut wood. It is actuated by nonsensical theories leading to the desire for a dominant race. This is the opposite to the outlook of the Soviet Union, which is working for race equality and for the use of science and cultural achievement for the raising of the standard of living and the advancement of knowledge. In keeping with this the whole population shows the greatest interest in science. People in Great Britain often ask what is the attitude of the Soviet Union towards the man of science in his work. He could say that he and his colleagues are encouraged, as in England, to carry out what work they wish.

The Soviet people show great interest in British science and literature. Works by Shakespeare, Bernard Shaw and Priestley are performed, and Dickens and Stevenson, to name but a few classical British authors, are widely read; and now in the War all Soviet scientific workers are giving every support possible to the struggle of the people to preserve their country and those things which are so dear to them, as well as to liberate the enslaved peoples of Europe. With the British Empire and the United States they have a common enemy, Fascism, and he appealed to British men of science and intellectuals to collaborate with their Soviet colleagues with whom they have so many ideals in common.

New Building for the Soviet Academy of Sciences

BEFORE the outbreak of hostilities, the main building of the new home of the Academy of Sciences of the U.S.S.R. had been started on the Krimsky Embankment of the Moscow River. The building was designed by the Soviet architect, Prof. A. V. Shchusev, who recently stated that this would be one of the largest buildings in the Soviet capital—755 ft. long, 328 ft. wide and $131\frac{1}{4}$ ft. high. The new building will house the presidium of the Academy, twelve institutes, a library with a depository for four million books, and two exhibition halls. One of the features of the building is a round conference hall, 118 ft. in diameter, with comfortable seating accommodation for a thousand persons. Connected with each of the two exhibition halls will be a semi-circular auditorium seating a hundred and fifty persons and specially fitted for demonstration lectures.

Each of the twelve institutes to be housed in the new building will have a meeting hall, a hall with cinema apparatus, laboratories and reception rooms. If circumstances permit, the major part of the construction work will be completed by 1943, when the presidium and the institutes of the Academy will begin moving into their new quarters. Alongside the main building will be erected a large depository for fifteen million volumes, and two museums—the History of the Earth and the History of Animal Life.

Large Aircraft for the R.A.F.

IT has recently been revealed that twenty Boeing "Flying Fortresses" (B-17.C.type), all of which have been flown across the Atlantic, are now in service with the Royal Air Force. The official R.A.F. title for these will be "Fortress 1". Further supplies of an improved design (B-17.E.) are under construction in the United States. These bombers, the largest at present in service, have a span of 104 ft. and a length of 68 ft. They are equipped with four engines of 1,200 h.p. each, supercharged, can maintain a speed of 305 miles an hour at an altitude of 25,000 ft., and have a ceiling of 36,000 ft. With speeds and heights of this order they can put up a reasonable defence against enemy fighters, and the problem of providing them with fighter escorts is simplified as their performance is comparable to that of their protectors. Particular attention has been paid to protective armament, the wide angle of fire over which the machine guns can traverse giving almost complete cover in any direction.

The load carried by these machines is 5,000 lb. over a range of 2,000 miles. This enables very large individual bombs to be carried, that are considered to be necessary for the destruction of certain types of targets not always susceptible to the effect of a similar total weight of smaller bombs, carried in a number of machines of less capacity. Also there is the tactical advantage of the relatively smaller requirement in trained personnel needed for the one large machine. The Minister of Aircraft Production, Lieut.-Colonel Moore-Brabazon, recently announced in Parliament that although these machines were the biggest in the world at the time they were made, we have now under construction "three types bigger than anything in America".

The Iraq Meteorological Service

THE fourth annual report of the Director of the Meteorological Service of the Government of Iraq, for the year ending March 31, 1940, deals with a period during which a variety of causes operated to increase the difficulties in the way of the orderly

development of this infant service (Government of Iraq: Ministry of Defence: Meteorological Service. Annual Report of the Director, No. 4: Year ending 31st March 1940. Pp. 30. Baghdad: Government Press, 1940). Measures taken in previous years to provide the most efficient service of information about the existing and anticipated weather on the various air routes of civil aviation "blossomed and bore fruit towards the end of the year", to quote the report, an achievement which practically coincided in time with a reduced demand for such information resulting from reduced civil aviation on account of the War. In addition there were the minor disturbances of continuity arising from the transfer of the service from the administrative control of the Officer Commanding the Royal Iraq Air Force to the Director of Civil Aviation and from a change of directorship, although the latter did not occur until the fourth day of the last month of the period covered by the report, when Mr. J. S. Farquharson relieved Mr. J. Durward, the first full-time director.

But the greatest obstacle to progress in national meteorological organization remained, as in previous years, that of getting suitably educated staff of the right calibre willing to take up the openings that become available in the expansion of such a youthful service. A consequence of this was that several of the observatories were maintained single-handed without a day's respite—no mean achievement when the climate of Iraq is taken into consideration. The calling up for military service of some of the trained staff was a contributory cause of this state of affairs. As regards the work of the Service, the report shows that a large part of this consisted in the carrying out, in spite of the obstacles just referred to, of a fixed scheme of distribution of information for the benefit of aviation, and supplying answers to various climatological inquiries. In addition, the first three of a series of non-routine publications described as "Occasional Publications" were completed. Of these the first and third dealt with climatological statistics —principally monthly mean temperature and rainfall—while the second was concerned with administrative regulations.

Expansion of Electrical Industries in Canada

MR. JOHN R. READ, president of the Canadian Westinghouse Co., Ltd., gave an interesting broadcast in Canada on the vital part being played by the Canadian electrical industries in the war effort (Bull. Hydro-Electric Power Commission of Ontario). He stated that the Canadian worker has more electrical energy to call upon than anyone else in the world except the Norwegian. More than 80 per cent of the power used for all purposes in Canada is electric power, and to-day the electrical plants of the Dominion can produce some nine million h.p., more than five times the amount of electric power which was available for the service of Canadian industry during the War of 1914–18.

Enormous supplies of power and power equipment are required in the manufacture of explosives. Because Canada has the power available, a total of 106 million dollars is being expended in creating great chemical and munitions plants in various parts of the country. A large new aluminium plant is now being constructed in Canada, representing an investment of about fifty million dollars, and capable of producing when completed enough aluminium a year for the construction of about fifty thousand military aeroplanes. This will be an installation of 700,000 h.p.

It is much the same story with respect to all those other metals vital in war—gold, copper, nickel, lead and zinc. Almost one tenth of all the electric power used in Canada is employed by the mining industry. Ample power supplies have made it possible for the mines to increase their production to meet war needs. One of the very striking differences between the present War and that of 1914–18 relates to communications. Since 1918, the whole new world of radio has emerged, and radio equipment makes possible the constant co-ordination of military action. Radio is also a vital link in the national life. Already scientific men of the industry have moved far in the fields of television, facsimile transmission, electron optics and extremely high frequencies. More than 60,000 Canadians are engaged in the electrical industry. Their wages and salaries amount to more than one hundred and ten million dollars a year. The electrical industry of Canada well realizes the task which war imposes, the duty which it owes to democracy, to Canada, and to the ideals of its founders.

The Gas Industry in War-time

THE seventy-eighth general meeting of the Institution of Gas Engineers was held in London on June 11 under the presidency of Mr. George Dixon of Nottingham. At the luncheon Mr. Oliver Lyttelton, then president of the Board of Trade, and Sir Peter Bennett, of the Ministry of Aircraft Production, spoke in complimentary terms of the resilience of the industry and its valuable services under present war conditions. The technical business consisted in the discussion of a symposium in "The Gas Industry, 1941 and After"—nine short papers on topics of current interest and importance. These revealed a strong movement for reorganization and administrative concentration of the industry which it is felt consists of an excessive number of producing and distributing units. The number of standards of calorific value is excessive, with consequent undue multiplication in patterns of appliance and their cost. The success of grouping small undertakings and the establishment of 'gas grids' in promoting the freer use of public gas supply was taken as an example to follow. There are obstacles to reorganization in an old industry consisting of numerous and sometimes small local units. If, however, desirable changes are not undertaken spontaneously, it was suggested that they might be enforced by national action to meet urgent and national needs. Coal carbonization industries with their production of liquid fuel may, under post-war economic conditions, acquire a new and greater importance.

Road and Rail Transport in India

AN article by C. N. R. Rau in *Current Science* of March on "The Co-ordination of Road and Rail Transport" reviews recent experience of transport in the Empire both before and during the War, with special reference to India, and endeavours to indicate basic principles of service which should determine both the choice and organization of transport. Discussing the handicaps under which rail transport generally labours, Mr. Rau considers that the plea for a 'square deal' for the railways is well founded. He suggests that investigation is still required to determine how far co-ordination of inland transport can meet the recognized ideals of service, whether in the transport of goods or passengers, or from the point of view of operating efficiency and safety, and indicates that both road and railway transport services might explore the field of public relations much more thoroughly. Emphasizing the importance of co-ordination, once it is clear as to the types of traffic best suited for one form or other of transport, he suggests that legislative or Government control, without nationalization, could with a judicious road policy, so shape the transport system of India that the two methods would work as complementary units, each performing the work best suited to itself and rendering the best service to the community.

The value of agreements between the two systems, of mutual recognition, and the organization of road transport with reference to railway stations, for example, by the use of railway stations as bus termini, the interavailability of tickets, publicity of one service on the other, the application of "undue preference" and "common carrier" clauses to both systems, are among concrete suggestions advanced for the promotion of efficient transport in India, as well as consideration of the establishment of an organization under joint auspices, entrusted with the task of collecting, analysing and collating all relevant information in regard to problems of common interest. Road operating statistics should be published on the same lines as railway statistics, and the State should insist on the organization of road haulage on the lines adopted by the railways, so that the two systems can negotiate on an equal footing and share the benefits of any co-ordination schemes.

Diesel-Electric Tube Locomotive

THE London Passenger Transport Board is utilizing parts of old railway coaches from the "Central Line" of the underground system for building at its Acton works Diesel locomotives for hauling ballast and maintenance trains, or for emergency use in the 'tubes'. These duties are at present performed by tank-type steam locomotives. It is arranged to collect current from the live 600-volt track rail, or be propelled by its self-contained generating set as circumstances may require, and it is capable of hauling a 600-ton train on the level or one of 300 tons up a 1 in 34 gradient. The length of the vehicle is 57 ft., its width 8 ft. 2 in., its height 9 ft. 5 in., and the tare weight in running order is 62 tons 12 cwt. According to the *Electrical Review* of May 16, only the oil engine and generator with some switchgear had to be purchased in fabricating the train. The passenger compartments of two old driving cars were cut off, leaving the equipment compartments with motors and driver's cabs; these were joined together. The locomotive can be controlled from either end. Its engine is of the Petter 'superscavenge' airless injection, two-stroke cycle, cold starting type. The six cylinders develop 506 b.h.p. at 675 r.p.m. The engine is started by means of compressed air at 350 lb. per sq. in. The generator, which was made by the Brush Electrical Engineering Co. Ltd., is a level-compounded shunt machine with a continuous rating of 750 amp. at 450 v. The traction equipment consists of two series-parallel sets with automatic relay controlling notching.

Control of Pig Raising

C. P. McMEEKAN has furnished what, in view of the present food situation, should prove a valuable analysis of the growth and development of the pig with special reference to carcass quality characters. The five parts (*J. Agri. Sci.*, **30**, 1940; **31**, 1941) with their appendixes have been conveniently issued together. The aim of the work is to provide a base from which to control the raising of pigs as meat-producing animals. It is, therefore, particularly concerned with the effects of nutrition upon not only the growth and size of the pig as a whole but also upon the quality of the meat produced. The author admits that the term 'meat quality' is not possible of exact definition in a form capable of universal application, but some approximation can be made thereto. Of course it will vary with the use to which the meat is to be put and also with the local tastes and requirements. The bulk of the memoir is naturally concerned with the statement of a number of experiments and an analysis of their results, but general ideas are not overlooked and the work concludes with a review of the main principles that emerge and their wider application even to human beings.

British Natural History

DESPITE the increasing difficulties and demands upon the spare-time, amateur as well as professional, natural history continues in Great Britain. The summer *Bulletin of the British Empire Naturalists' Association* records the continuance of branch activities at Bournemouth, Merseyside, Derbyshire, North Cotswold, London, Manchester and Lancaster; in fact only two branches have closed since the outbreak of war. 1941 field records include the first definite nesting of the fulmar on St. Bee's Cliff, Cumberland; Bewick's swans and a green sandpiper on spring passage in Lancashire; a fire-crest at Stanmore, Middlesex, on April 6; siskins at Farnham, Surrey, April 30, and a bird migration survey over twelve counties. The 1940 edition of the Burton-on-Trent Natural History and Archæological Society records has appeared and directs attention to the opportunity for studying the changes the war-time felling of woods will have upon bird, plant and insect life.

The Merseyside Naturalists' Association is shortly publishing its new book on the birds of west Lancashire and west Cheshire; the Blackburn Naturalists' Field Club reported a record attendance, averaging two hundred, at its indoor evening meetings last winter, and the recent summer meeting of the North-East Lancashire Naturalists' Union at Darwen was very well attended. The Thunder Census Organization is carrying on its work and has just issued its fifth annual report from Langley Terrace, Oakes, Huddersfield, and particulars of trees struck by lightning are being collected. The Liverpool Botanical Society is continuing its field work for the publication of its "Flora of South Lancashire" and the North of England Zoological Society, Chester, has made its monthly journal the organ for reporting the activities of other zoological collections since the *Animal and Zoo Magazine* of the London Society suspended publication, and London, Dudley and Maidstone Zoos contribute to the June issue.

Medicine in Saint-Simon's "Mémoires"

IN a recent paper on this subject (*Proc. Roy. Soc. Med.*, **34**, Sect. Hist. Med. 31; 1941) Dr. J. D. Rolleston claims that this work, which covered twenty-one years of the reign of Louis XIV and eight years of the Regency, contained many passages of medical interest, though they had received little attention from medical historians. They could be classified under the headings of prevalent diseases, portraits of contemporary doctors and miscellaneous topics. Small-pox was by far the most frequent of all the diseases mentioned by Saint-Simon, and its prevalence among royal personages and courtiers was a striking proof of the efficacy of Jenner's discovery, as since that time the disease was almost unknown among the upper classes in whom conscientious objectors were rare. Among chronic infections described in the "Mémoires" syphilis undoubtedly held the first place and claimed several courtiers of both sexes among its victims. Many cases of lung disease, probably of a tuberculous nature, are also mentioned. As might be expected owing to their indulgence in highly nitrogenous diet, large consumption of alcohol and lack of exercise, a great number of courtiers as well as Louis XIV suffered from gout. Several examples of nervous and mental diseases as well as alcoholism and cancer are also alluded to by Saint-Simon. Of the thirteen surgical operations mentioned five were for stone in the bladder and four for fistula *in ano*, a complaint which, after the operation on Louis XIV, became as fashionable as appendicitis did more than two centuries later after the operation on Edward VII.

The "Mémoires" also contain brief indications of three diseases—achondroplasia, spondylitis deformans and hæmophilia—long before they were described in scientific medicine. As regards his attitude towards the medical profession, Saint-Simon, like many other distinguished laymen before and since his time, did not appear to have a liking for doctors, as is shown by the frequency with which he declared that they had not understood the nature of the disease which they were treating. On the other hand, he was unsparing in his eulogies of individual doctors, such as Fagon, Louis XIV's physician, Mareschal, his surgeon, and Hyghens, the king of Spain's physician who attended Saint-Simon during his attack of small-pox. The miscellaneous topics of medical interest mentioned in the "Mémoires" include longevity, sexology, spas, poisoning, post mortem examinations and the illnesses of Louis XIV.

History of Endocrinology

IN a recent paper on this subject read before the Section of the History of Medicine of the Royal Society of Medicine (*Proc. Roy. Soc. Med.*, **34**, 303; 1941) Dr. A. P. Cawadias said that three periods could be distinguished in the historical development of endocrinology. The first was the descriptive period, the second was one of analytic endocrinology and the third or contemporary period was that of synthetic endocrinology. The first description of endocrine diseases was given long before there was any accurate knowledge of endocrine physiology, being found in the writings of Hippocrates, who studied hypo-orchidism and climacteric hypo-ovarism. Only after some advance was made in the knowledge of glandular physiology, however, were endocrine diseases introduced into nosography. The earliest of these was hypothyroidism, studied by T. Curling in 1850 and later by C. H. Fagge in 1871 and Sir William Gull in 1873. Hypo-adrenalism was described by Addison in 1855, when endocrine nosography first made a real start. A notable advance in the history of endocrine diseases was made by the introduction of endocrinotherapy. This began with Brown-Séquard in 1889, reached a notable peak with the introduction of thyroid organotherapy by G. R. Murray in 1890, and developed intensively in recent years, outstanding events being the introduction of insulinotherapy by Banting in 1921, of the various sex hormones and of cortin.

The Wyperfeld (Mallee) National Park

THE Mallee National Park in Victoria, known as "Wyperfeld", an account of which appeared in NATURE of August 12, 1939, p. 272, has received a substantial addition of 51,840 acres, owing to the far-sighted action of the acting premier of Victoria, Mr. Lind. This makes a total area of 138,700 acres. The land added, known locally as the "Desert", is useless for purposes of production, but contains the mound builder, known as the 'lowan', and is a feeding-ground for birds. The Park is situated in the most arid part of the State with a capricious rainfall of 9 in. and great evaporation. In spite of this dryness it is well stocked with birds of the cockatoo and parrot family, also lowans and emus. It also contains a number of black-faced kangaroo. There is at present only one well in the area, and exactly where these animals get the necessary water is not known. The trough at the well is used by some of the birds and by bees, but so far the kangaroos have not been seen to use it. A somewhat similar problem of water supply can be seen in the Egyptian Desert bordering on the Mediterranean which, whereas it is lifeless in the day-time, is stocked with jerboas and various reptiles at night.

A Matrix Machine

With the growing application of matrix algebra, especially in the factorial analysis of psychological data, there is an increasing demand for a machine that will multiply matrices. Such a machine has now been produced in the United States by the International Business Machines Corporation, assisted by a research grant from the Carnegie Foundation, and is described in *Psychometrika* (5, 289; 1940). It uses an electric circuit in which one set of connexions is made by special marks on record sheets, one for each row in the first matrix, and the other set by plug wires corresponding to a column of the second matrix. The product of a matrix with any number of rows and up to 15 columns by a second matrix consisting of a single column is thus found, the results being read off on a meter. If the second matrix has more than one column, one column at a time is dealt with. The machine is in use in the psychological laboratory of Dr. L. L. Thurstone of Chicago, and the results appear to be accurate to two significant figures.

The International Seismological Summary

The International Seismological Summary for the second quarter of 1934 has just been received. It contains the determinations of 144 epicentres by the workers at Oxford, from all the available evidence sent by seismological observatories throughout the world. Sixty-two of these epicentres are new and eighty-two are repetitions from old epicentres, again showing the tendency of earthquakes to recur. Fifteen of the earthquakes have deeper focus than normal and one on June 29, 1934, at 8h. 25m. 20s. G.M.T., has a calculated focus 0·106 of the earth's radius below normal, which is at a greater depth than that of any earthquake previously treated in the summary. The epicentre of this shock was at 6·1°S., 123·4°E., which is in the Banda Sea close to and immediately east of the town of Baoebaoe in the island of Celebes in the Dutch East Indies. The area is well known to be frequented by deep focus earthquakes. In view of the accuracy with which the epicentre is known, the numerous data have been used to extend a table of corrections which may be applied to epicentral distances to produce agreement between observed and calculated times of the *P* wave.

Society of Chemical Industry

At the sixtieth annual meeting of the Society of Chemical Industry, held on July 8, Dr. W. Cullen, the well-known consultant in chemical and metallurgical engineering, was elected president in succession to Prof. J. C. Philip, who has occupied the post for two years. According to the Council's report, membership at the end of 1940 stood at 3,920, a decrease of only 77 on the total for the previous year; since then, however, many hundreds of new members have joined the Society, a reflection no doubt of the expanding chemical industry of Great Britain. The Society's Medal, the oldest of its distinction, has been awarded to Sir Robert Pickard, director of research for the British Cotton Industry Research Association at the Shirley Institute, who delivered an address on "The Influence of Science on National Life". The Society is to be congratulated on successfully overcoming the difficulties created by two enforced evacuations by its offices.

Announcements

Prof. F. A. Lindemann, who had been created a baron (see Nature, June 21, p. 772), has taken the title of Baron Cherwell, of Oxford in the County of Oxford.

Lord Horder has been appointed by the Minister of Food to be his personal adviser on medical aspects of food problems.

The first Charles Chree Medal and Prize of the Physical Society will be presented to Prof. S. Chapman, professor of mathematics in the Imperial College of Science and Technology, on July 25. Prof. Chapman will deliver an address on (1) Chree and his work on geomagnetism; (2) geomagnetic time relationships; (3) the future of world magnetic surveying.

Prof. J. B. Conant, president of Harvard University, was elected an honorary fellow of the Royal Society of Edinburgh at a meeting held on July 7. At the same meeting the Gunning Victoria Jubilee Prize for the period 1936–40 was presented to Sir James Irvine for his distinguished contributions to organic chemistry; and the Makdougall-Brisbane Prize for the period 1938–40 to Mrs. E. L. Ince, on behalf of her husband, the late Dr. Edward Lindsay Ince, for his papers on "The Periodic Lamé Functions", published in the *Proceedings* of the Society.

The Edinburgh Association for Sending Medical Aid to Foreign Countries this year celebrates the centenary of its foundation.

The following appointments and promotions in the Colonial Service have recently been made: B. de L. Innis (agricultural superintendent, Gold Coast), assistant botanist, British West Indies, Central Sugar Cane Breeding Station, Barbados; J. T. Purvis (senior assistant livestock officer), agricultural officer, Tanganyika Territory.

To promote the interests of science in the south of the United States, a new Southern Association for the Advancement of Science has been organized. Dr. George D. Palmer of the University of Alabama, who served as president during the organizing period, is now secretary-treasurer. Dr. G. H. Boyd of the University of Georgia is president-elect. In addition to the encouragement of scientific research in general and its application to problems of the South in particular, the declared objectives of the new Association include the setting up of a roster of Southern research talent available not only for specific southern problems but also for possible contributions to national defence.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Tastes of Oxygen and Nitrogen at High Pressures

WHILST carrying out experiments on behalf of Admiral Sir M. E. Dunbar-Nasmith's Physiological Sub-Committee for saving life from sunken submarines, we and other subjects have had occasion to breathe oxygen, air and other gas mixtures at high pressures.

When oxygen was breathed at 6 atmospheres, several subjects noticed a peculiar taste, which was enhanced at 7 atmospheres. None of them noticed it at 3 atmospheres. The taste is both acid and sweet. Two subjects described it as "like dilute ginger beer", and "like dilute ink with a little sugar". It was felt unevenly, by one subject mainly on the back of the tongue, by another beneath it. In one case it persisted for some minutes after ceasing to breathe oxygen. It may be remarked that although oxygen is a convulsant at such high pressures, it can be breathed with complete safety for long enough to taste it.

In air at 10 atmospheres, and sometimes even at 8 atmospheres, a number of subjects reported a taste which is variously described as harsh, metallic, and indefinable. It is certainly not due to oxygen, and one subject who tasted it regularly in air did not do so when mixtures in which the nitrogen of air had been replaced by helium or hydrogen were breathed at 10 atmospheres. We therefore attribute it to nitrogen.

Not all subjects reported these tastes. This was probably often due to the fact that other sensations were distracting them, and to the narcotic effect of nitrogen at high pressures. However, one subject who was repeatedly on the look-out for both tastes has never tasted nitrogen, and only tasted oxygen very faintly at 7 atmospheres. His sense of taste is, however, poor as a result of cerebral concussion.

We conclude that the taste threshold for oxygen lies below 6 atmospheres and for nitrogen below 8, in about half of the persons tested. So far only one person has reported an abnormal smell, in compressed air, but perhaps oxygen and nitrogen may have smells at still higher pressures.

It is clearly inaccurate to describe a gas as inodorous and tasteless. On the contrary, most or all gases may be expected to display these properties at sufficiently high pressures, just as they liquefy at sufficiently low temperatures. Whether men can survive the pressure under which, say, hydrogen develops a taste or smell is, of course, as yet unknown.

We have to thank the Admiralty and Messrs. Siebe Gorman and Co. for making this research possible.

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S.W.1.

Ascorbic Acid and Resistance to Low Oxygen Tension

IN an article published in the *Lancet* of June 28, Stewart, Learmonth and Pollock record experiments which show that the intravenous administration of ascorbic acid prolongs the life of cats after severe hæmorrhage. They suggest that ascorbic acid secures a more adequate supply of oxygen to the tissues.

Experiments which have been carried out in this Institute by Dr. B. G. B. Lucas, in an attempt to make oxygen more available to the tissues of animals subjected to low atmospheric pressures, have yielded similar results. Both methylene blue and ascorbic acid, administered intraperitoneally, have been found to increase the resistance of mice and rats to low oxygen tensions. A mouse, injected with methylene blue or ascorbic acid, may survive a number of consecutive exposures to atmospheric air at a pressure of 120 mm. mercury, while, on each occasion, an untreated companion succumbs.

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Pharmacological Classification of Steroid Hormones*

UP to the present, the physiological classification and terminology of steroid hormones was based either on one of their outstanding actions ('œstrogens', 'progestins') or on their source of origin ('corpus luteum hormone', 'adrenal cortical hormone', 'testis hormone'). Such a classification is no longer possible, since we know, for example, that 'testis hormones' may originate in the adrenal cortex and may exert 'œstrogenic' actions. In spite of the considerable overlapping between the physiological actions of the steroid hormones, they can and must be classified into certain groups. It is felt that the best solution of the problem is to *classify the steroid hormone actions according to the degree to which they are able to imitate or substitute for the function of a certain endocrine gland.* Accordingly these groups might be given names reminiscent of the glands and yet indicating that this does not imply that such glands are the only source of the hormone.

Thus progesterone imitates the action of a corpus luteum and œstradiol that of an active follicle even though these hormones may originate from cells other than those of the corpus luteum and the ovarian follicle respectively. The grouping of the steroids into œstrane, androstane and pregnane derivatives is a satisfactory basis for the classification of their

* Abridged.

chemical properties. As a designation for the whole groups of hormones having a structure reminiscent of the sterols, Callow and Young[1] suggested the name of 'steroid' which has generally been accepted. The Greek ending 'oid' derived from ειδος meaning form, has often been used in pharmacology to designate compounds similar in their actions to those described by the work preceding this ending (for example, toxoid). Accordingly, the four main types of steroid hormone-like actions might be described as corticoid, luteoid, folliculoid and testoid. Thus without introducing any essentially novel terms, we could classify the steroid hormones into four main pharmacological groups according to the principles mentioned above :

Corticoid = having activity of : cortin, adrenal cortical hormone, principle maintaining life of adrenalectomized animals, etc.

Luteoid = having activity of : progestin, corpus luteum hormone, progesterone, luteine, β-hormone, kythine, luteohormone, corporin, relaxin, mucifying hormone, luteocrinine, etc.

Folliculoid = having activity of : œstrin, œstrogenic hormone, feminine, gynæcogenic hormone, menformon, folliculin, α-hormone, follicular hormone, female hormone, etc.

Testoid = having activity of : androkinin, male hormone, testis hormone, androgenic hormone, etc.

It may incidentally be mentioned that the term 'cortin' has now lost its original meaning as a generic term for adrenal cortical hormone activity since Hartman *et al.*[2] now distinguish between the "vital factor, cortin" and the "sodium factor". This means that desoxycorticosterone acetate is both a 'cortin' and a 'sodium factor', while some of Hartman's cortin preparations are apparently devoid of the latter activity. If this type of subdivision were carried over to the group of the testoids, androsterone would have to be called prevailingly a 'prostate factor' and testosterone a 'seminal vesicle factor'. Subdivision carried to this degree is of no particular value as it eventually leads to the mere statement of single characteristics which can much better be done by the generally accepted practice of merely stating the degree to which the compound has 'metrotropic', 'mammotropic', 'renotropic', pituitary-enlarging, life-maintaining, etc., ability. While the determination of all these activities is evidently of importance, it is felt that for the reasons mentioned above, the single action can be used as a basis for a classification. On the other hand, the classification suggested in this note has none of these deficiencies, and the proposed group names are equally applicable to artificial compounds and true hormones. It is hoped they will prove useful at this time when so much work is done on a multitude of newly synthetized steroid compounds with hormone activity.

Department of Anatomy, HANS SELYE.
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June 16.

[1] Callow, R. K., and Young, F. G., *Proc. Roy. Soc.*, A, **157**, 194 (1936).
[2] Hartman, Frank A., Spoor, H. J., and Lewis, L. A., *Science*, **89**, 204 (1939).

Nomenclature of Pituitary Autacoids

THE nomenclature of pituitary autacoids is unsatisfactory, and current terminology with reference to those of the anterior lobe is particularly at fault. The terms thyrotropic and gonadotropic are in general use. These terms are misleading. The Greek word τροπος or τροπη means *a turn, return,* or *turning about* and the verb τρεπω from the same root can be used transitively to signify *direct* or *guide*.

We have long-established precedent for this root in current biological literature. The *phototropic* or *geotropic* behaviour of a plant signifies that it turns towards or away from light or the centre of the earth. The same words have also been used to describe the behaviour of an animal when it moves to or from a source of light or the earth's centre. Students of animal behaviour have very properly recognized that this is inconsistent with scientific usage. Consequently they have substituted *phototaxis* and *geotaxis*.

Dr. A. S. Parkes has suggested the use of the term *gonadotrophic* instead of *gonadotropic*[1]. The meaning of the Greek root of the suffix *trophic* would indicate that the hormone feeds the gonads. This is far from certain and it is possible to choose a more appropriate root which can be applied to all the activities of the pituitary gland. It is certain that there is some physiological connexion or link between the specific activities of the anterior lobe and the thyroid, gonads, etc.

One Greek word which meets our requirements is δεσμος, which means a bond, fetter, or link. This suggests the following terminology for the anterior lobe autacoids :

(1) thyrodesmic (*thyrotropic*)
(2) blastodesmic or *growth-promoting*
(3) oodesmic or *follicle-stimulating*
(4) xanthodesmic (*luteinizing*) } gonado-desmic
(5) androdesmic or *testicle-stimulating*
(6) galactodesmic (*galactogogue*)

One objection to the items of this list is that growth-promoting is sufficiently explicit. For those who prefer native words to international terms, thyroid-stimulating is certainly better than thyrotropic.

Existing terminology of the posterior lobe autacoids is not open to the same objections. The term oxytocic is not inherently inconsistent with established usage of Greek affixes. Still, it is open to the criticism that it contains no familiar root which suggests its meaning. For the English-speaking scientific worker, uterine stimulant is therefore a better term than oxytocic activity. From every point of view Hogben's *melanophore stimulant* is preferable to *chromatropic*. Until it is possible to distinguish between the substances responsible for melanophore stimulation and erythrophore stimulation the adjectives *melanodesmic* and *erythrodesmic* might be appropriately used. *Pressor substance* is sufficiently explicit from the point of view of the English-speaking world and is in accordance with international usage. So also is the term *anti-diuretic*. For those who prefer a uniform nomenclature, I suggest the following :

(1) hæmodesmic (*pressor*)
(2) splanchnodesmic (*oxytocic*)
(3) (*a*) melanodesmic (*b*) erythrodesmic
(4) nephrodesmic
(5) leucodesmic (the at present hypothetical "*W*" substance of Hogben and Slome).

Natural History Department, F. W. LANDGREBE.
University of Aberdeen.
June 23.

[1] NATURE, **141**, 36, 73 (1938).

A Possible New Cure for Acarine Disease of Honeybees

ACARINE disease, sometimes still known as 'Isle of Wight disease', as its name implies is caused by the invasion by the mite *Acarapis woodi* of the thoracic tracheæ of the adult honeybee. Although no longer epidemic, this complaint still causes the complete destruction of many colonies of bees annually and the serious weakening of many others.

To kill the mites inside the tracheæ of an infected bee, some volatile substance which exerts a marked differential toxicity upon the bee and *A. woodi* would appear necessary. Up to the present a small number of substances or mixtures has been found to have properties tending towards the desired objective. These have not, however, been found to be entirely satisfactory. Work has therefore been carried out here during the last two and a half years in an attempt to find a volatile material which kills *A. woodi* in the tracheæ of the honeybee, does not harm the adult bees or their brood, and is simple and cheap to apply. Many substances were tested with varying degrees of success and it has been found that the vapour of terpineol, a heavy faction of crude pine oil, gives the results desired, being highly toxic to *A. woodi* but harmless to bees. In one experiment twenty-five bees which were heavily infected were subjected to the vapour of terpineol for five days and, at the end of this period, all the mites were found to be dead, whereas twenty control bees were all found to contain many live mites.

Experiments are now being conducted to determine a simple and satisfactory method of administering terpineol to a colony of bees.

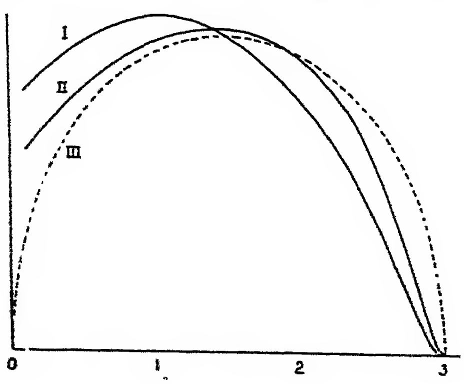
It is hoped that the results obtained with this substance will be published in full in the near future.

C. G. BUTLER.

Bee Department,
Rothamsted Experimental Station,
Harpenden.
June 20.

Production of Electron Pairs

SOME time ago we described a method[1] for calculating rigorously (neglecting screening) the cross-section for production of electron-positron pairs in the field of a nucleus by a beam of γ-rays. This method also gave the energy distribution of the electrons or positrons. Results were given for lead, atomic number $Z = 82$, for γ-rays of energies $h\nu = 5\ mc^2$ and $3\ mc^2$, and were in reasonably good agreement with experiments on pairs produced in



thin foils. Calculations have now been made for $Z = 54$, $h\nu = 5\ mc^2$, to enable direct comparison to be made with Wilson chamber experiments on xenon and iodine. The final results contain about 20 per cent of (additive) extrapolated terms and should be accurate to about 10 per cent. The old calculation for lead has been extended and a small error corrected: the revised figures are given below.

The values of σ, the cross-section per atom for absorption by pair production by γ-rays of energy $5\ mc^2$, for atomic numbers 82 and 54 are given in the table, together with the values calculated on the Born approximation[2]. The values of $\bar{E}_+ - \bar{E}_-$ are also given, where $\bar{E}_+$ and $\bar{E}_-$ are the average energies of the positron and electron respectively.

Z	54	82
$\sigma \times 10^{24}$	1·1	3·0
$\sigma \times 10^{24}$ (Born)	1·1	2·5
$(\bar{E}_+ - \bar{E}_-)/mc^2$	0·27	0·51

The energy distribution of the pairs produced by radiation of energy $5\ mc^2$ is shown in the accompanying figure. The abscissæ are electron-energies in units of mc^2 and the scale of the ordinates is arbitrary, the curves being adjusted to have the same area. Curves I, II and III are respectively for $Z = 82$, $Z = 54$ and the Born approximation. Curves I and II theoretically tend to a finite limit for zero energy of the electron, but these values have not been calculated.

J. C. JAEGER.

University of Tasmania,
Hobart.
May 28.

[1] Jaeger and Hulme, *Proc. Roy. Soc.*, A, **153**, 443 (1936). See also NATURE, **137**, 781 (1936).

[2] Bethe and Heitler, *Proc. Roy. Soc.*, A, **146**, 83 (1934).

Thin Glass for Microscope Cover-Slips

MICROSCOPISTS will note with interest and appreciation the recently recorded centenary of the production by Messrs. Chance Brothers of thin glass for microscopic purposes[1].

There is good reason to believe that the production of this glass was due to the insistent and increasing demand by the early members of the Royal Microscopical Society. It is recorded that one of the first things the Council did in 1840 when thin flatted sheets first became available was to consider and standardize the size of the specimen slide at 3 in. × 1 in.—which size has since become universally adopted—and to install a device for the use of members for cutting both slides and cover-glasses from these sheets.

While it would be difficult to produce with certainty the earliest instance of the use of glass in place of talc, there is strong evidence to show that it was used for some ten years before thin flatted sheets became available through the enterprise of Messrs. Chance Brothers.

In 1831 Andrew Ross made the first achromatic objectives on Lister's formula. In 1832 J. T. Cooper suggested the use of Canada balsam as a mounting medium for the preservation of microscopic specimens. Now in both these matters the use of the talc disk would appear to be impracticable; and further, the development and purpose of the correction collar to high-power objectives which Ross brought out in 1837 was to correct the spherical and chromatic

aberrations introduced by the adoption of the cover-glass.

It appears to have been customary in those early days for microscopists to select small fragments of thin glass obtained from large bubbles blown to bursting, and to use the suitable pieces thus obtained for cover-glasses. The helpful warning then given to the members not to use too much pressure in placing the cover-glass over the specimen had an obvious meaning. A few of these early slides are still preserved in the Society's historical collection.

The production in 1840 by Messrs. Chance Brothers of what was then described as thin and very thin flatted sheets was a valued contribution to the study and advancement of scientific microscopy in which Great Britain then led, and continues still to lead, the world. Microscopists everywhere still regard with warm congratulation the long and honourable record of pioneering achievement of this distinguished firm in the production of glass for optical and other scientific purposes.

C. TIERNEY.

Royal Microscopical Society,
B.M.A. House,
Tavistock Square,
London, W.C.1.

NATURE, 147, 803 (1941).

"A School Chemistry"

As the author of "An Introduction to Chemistry", I wish to protest against the review of this book which appeared in NATURE of March 22. The reviewer has devoted so much space to criticisms of controversial or trivial matters that he has failed to emphasize the special features of the book. The general character of several of his remarks can be judged from the following selection, to which I have added some comments.

(1) " . . . phosphorus was discovered by Brand, not Brandt, probably in 1674 not 1669." The implication in the first part of the statement is incorrect; Brand, not Brandt, is given in the text. The reviewer may be correct about the date, but a letter from Brand to Leibniz (G. H. Peters, *Arch. Geschichte Naturw.*, **4**, 206 (1912); **7**, 92 (1916)) indicates the date 1669, and this appears to have been accepted by Mellor, "Thorpe's Dictionary" and the "Encyclopædia Britannica".

(2) "The statement that argon was first called 'aeron' (p. 118) is new to the reviewer, but may be correct." The suggestion in this statement is ungenerous. The author's remark about aeron is substantiated by a letter Rayleigh wrote to Lady Frances Balfour in 1894 (actual quotation, pp. 212–13, "Crucibles", by B. Jaffe).

(3) "The style is generally good, but it is surprising to find on p. 482 the direction to 'tip' a solid into a vessel." The use of the word 'tip' is in accordance with the definition given in the Oxford Dictionary, and the author has been informed by two well-known examiners that they see no reason for criticism on technical grounds.

(4) "Black's date is 1755 not 1775." The correct date of 1755 is given higher up on the same page, indicating that a slip was made in proof-reading. The reviewer might, instead, have pointed out that this section gives a fairly detailed account of Black's masterly researches on the mild and caustic alkalis, and that this is unusual in a School Certificate text-book.

(5) "the definition of a 'pure substance', as given, would include solutions." The author was careful to amplify his definition of a compound (not substance) by stating that it included the law of constant proportions, namely: "a pure compound always contains the same elements in the same proportions by weight." This effectively excludes saturated solutions and eutectics, since their composition varies with temperature and/or pressure.

(6) "Jabir and Geber are confused, as in other places (pp. 257, 310, 344, etc.)." Dr. E. J. Holmyard, an authority on Arabian science, says in "The Great Chemists", p. 11, "The greatest chemist of Islam . . . was Jabir ibn Hayyan, who is more familiar to Western readers under the name of Geber". The "Encyclopædia Britannica" confirms this view, so that there is at least some authority for the author's 'confusion'.

A. C. CAVELL.

Uppingham.

One object of a review is to direct attention to points in a book on which there may be differences of opinion even among experts, and it is generally accepted that such discussion is useful and interesting. Mr. Cavell has raised one or two points which merit further consideration.

(1) In an elementary work, where no authorities are quoted, it is best to follow the modern experts. The date 1674 is now generally accepted for the discovery of phosphorus, as Mr. Cavell now seems to imply, and it is given, for example, in Roscoe and Schorlemmer and in the new edition of Mellor's "Modern Inorganic Chemistry". The matter of the letter of Leibniz is dealt with in special publications. The references to Mellor (presumably the large "Treatise", in which all statements, right and wrong, are quoted), Thorpe's "Dictionary" and the "Encyclopædia" are beside the point. The author of a book is expected to use critical judgment.

(2) As the reviewer stated, the point about the name of argon was new to him but might have escaped his attention. He consulted a pupil of Ramsay's on the matter, but was told that nothing was known of it and that it was improbable. It is interesting to have the source indicated. Whether it is useful to mention it in an elementary book is questionable. The statement in the review is quite unobjectionable and leaves the matter open.

(3) Other examiners object strongly to the use of such words as 'tip' to describe careful quantitative work, and it is specifically condemned in a report of the London Higher School Certificate examiners. Some teachers may encourage such slipshod words but most would, the reviewer thinks, not favour them.

(4) Most authors are grateful when errors of any kind are pointed out.

(5) The reviewer sees no reason to modify what was said under this head and adheres to his opinion.

(6) The statement that the mineral acids were discovered by Jabir is not accepted by the modern authorities on Arabic science, such as Ruska. The statement quoted from Holmyard is perfectly correct but has no real bearing on the matter. The point, which seems to be missed by the author, is the relation between the writings of Jabir (the authenticity of which has also been questioned) and the Latin work which goes under the name of Geber. The information in the book is based on old-fashioned sources and requires correction.

THE REVIEWER.

LIGHT OF THE NIGHT SKY AND TERRESTRIAL MAGNETISM

By D. R. BARBER
AT LICK OBSERVATORY, CALIFORNIA

ALTERNATIVE theories[1] that seek to explain the mechanism of the selective emission forming the principal component of the night-sky spectrum postulate solar excitation as the primary cause. On this premise the initial ionization of the gas molecules (O_2, N_2) that are known to exist in the terrestrial high atmosphere is effected either by direct absorption of ultra-violet radiation, or by bombardment with high-speed electrons presumably emitted from the photospheric layers.

Now it is an observed fact that the terrestrial magnetic field is, in part, due to extra-terrestrial influences of solar origin. Hence it appears logical to presume that a significant correlation should exist between the luminous activity of the night sky and solar activity. The magnitude of the latter will be reflected in the perturbations of the magnetic elements, and a measure of this perturbation will yield a reliable index of such activity. S. Chapman[2] has stressed the desirability of investigating the problem experimentally but, hitherto, attempts to reveal a connexion of this nature have not met with conspicuous success. Lord Rayleigh and H. Spencer Jones[3] find some evidence of an enhanced nocturnal luminosity on magnetically disturbed days, but their results are inconclusive.

Systematic observations of the yellow-green (5577 A.) radiation from the night sky obtained at the Lick Observatory, Mount Hamilton, California, which I have made, using a concentric-field visual photometer[4], offer experimental evidence of an intimate connexion between measures of luminous activity and those of magnetic disturbance.

Values of nocturnal luminosity over an area of sky approximately four square degrees in extent at the north celestial pole were obtained during five months in 1940 on nights when excellent photometric conditions prevailed. The observations here referred to were made at five-minute intervals, and were restricted to those hours of the night when no direct, or scattered moonlight, or twilight was visible above the horizon. The photometric measures were reduced to an arbitrary (linear) scale of luminosity. From these, mean nightly values of the luminosity L, the range of luminosity ΔL, and the luminous 'activity', that is, the product $L.\Delta L$, were computed for each epoch. The complete series of observations was examined in conjunction with the Mount Wilson magnetograph records of horizontal intensity H, which were made available for this purpose by courtesy of the Carnegie Institution of Washington.

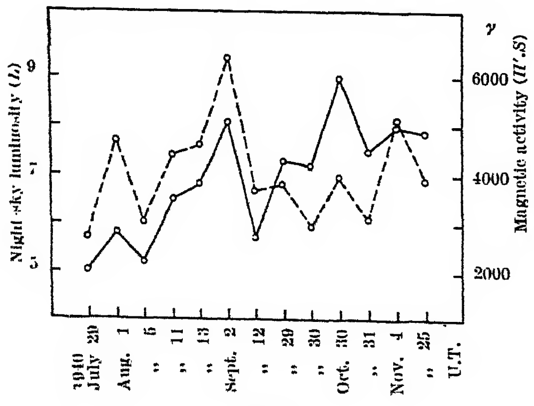


Fig. 1.

COMPARISON BETWEEN NIGHTLY VALUES OF NIGHT-SKY LUMINOSITY AT MOUNT HAMILTON (SOLID LINE) AND MEASURES OF MAGNETIC ACTIVITY AT MOUNT WILSON FOR PRECEDING DAY (BROKEN LINE).

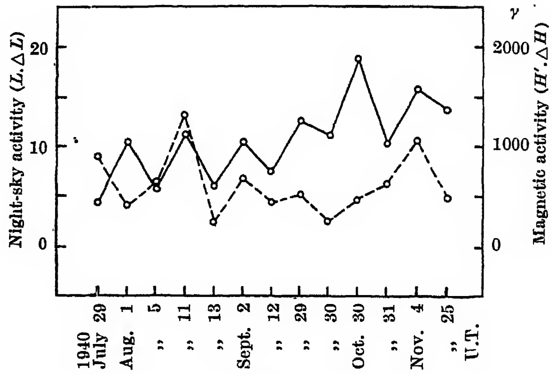


Fig. 2.

COMPARISON BETWEEN NIGHTLY VALUES OF NIGHT-SKY ACTIVITY AT MOUNT HAMILTON (SOLID LINE) AND MEASURES OF CONCURRENT MAGNETIC ACTIVITY AT MOUNT WILSON (BROKEN LINE).

The results of the analysis are exhibited graphically in Figs. 1 and 2. The comparative curves of Fig. 1 represent plots of night-sky luminosity L (full line), and magnetic activity (broken line) against epoch of observation. The magnetic activity is expressed here as the arithmetical product of the mean ordinate H', and the diurnal range S, for the twenty-four-hour period *preceding* the nocturnal observations. The correlation coefficients for the paired points from the two curves are $+ 0 \cdot 79$ for the period July 29 to September 29 U.T., and $+ 0 \cdot 31$ for all days. It will be noted that there is some divergence of the curves for the later dates: this is primarily responsible for the lower value of the coefficient r derived from the complete series. The reason for this divergence remains a matter for speculation. It may be added that a direct comparison of the nocturnal luminosity curve with that representing a plot of the diurnal variation of H—the amplitude S of which is dependent on the degree of ionization during the hours of insolation—yields also a significant, but slightly lower, positive correlation.

The foregoing comparisons involved measures of magnetic activity over a period of time antecedent to that of the night-sky observations. The paired curves of Fig. 2 exhibit a comparison between the

activity of the night-sky light, as already defined, and the *concurrent* magnetic activity, expressed as the product $H'.\Delta H$, recorded at Mount Wilson 300 miles south-east of Mount Hamilton. Although the correlation between the two curves is less pronounced, and the earlier measures form interlocking points, the point-to-point correspondence is again evident. The coefficients of correlation, referred to the same periods of time as in the previous comparison, are $+ 0 \cdot 18$ and $+ 0 \cdot 11$ respectively. The much lower values of r may, in part, be accounted for by the fact that measures of activity involve observation of the rather rapid fluctuations in sky brightness that are likely to be influenced by localized meteorological conditions. Further, the plots of magnetic activity were derived from measures of H obtained at intervals of time comparable with those of the photometric records. In the circumstances a high degree of correlation would appear improbable.

The results of the foregoing comparisons furnish evidence regarding the reality of the suspected connexion between the two geocosmic phenomena under discussion. They indicate that the level of luminosity of the night sky is determined by the degree of solar ionization established during the hours of daylight, and that the relatively frequent, irregular fluctuations of luminosity which are observed to occur during the night can be attributed, in some measure, to the same agency as that responsible for the concomitant magnetic disturbance.

The general nature of this relationship is further corroborated by the close correspondence revealed by comparisons of the seasonal and diurnal trends in nocturnal luminosity with those of magnetic activity. The results of this latter investigation are presented elsewhere[5].

Further research, using a photo-electric technique, which is now in progress, aims at an extension of the comparative analysis to measures of nocturnal radiation in other spectral regions.

[1] Chapman, S., *Phil. Mag.*, **23**, 657 (1937); Dauvillier, A., *Rev. gén. d'élect.*, **31**, 303, 443, 477 (1932).

[2] Chapman, S., NATURE, **121**, 959 (1928).

[3] Lord Rayleigh and Jones, H. S., *Proc. Roy. Soc.* A., **151**, 22 (1935).

[4] *Pub. Ast. Soc. Pac.*, **52**, 319 (1940).

[5] *Lick Obs. Bull.*, 505 (1941), in the Press.

SPIRITUS VITALIS

DURING the past ten years evidence has been accumulating that the reduction of carbon dioxide, a process widely thought of as unique to green plants, may actually be a characteristic of many and widespread organisms and perhaps indeed of universal distribution in living cells. Much of this evidence has been brought together by J. W. Foster, S. F. Carson and S. Ruben (*Chronica Botanica*, 6, No. 15, 337; 1941) in an instructive article under the above title and with a useful list of key references.

In addition to the well-known cases of chemosynthesis introduced by Winogradski (for example, sulphur bacteria, nitrifying bacteria) it is now recognized that some purple bacteria absorb carbon dioxide in light in the presence of sulphuretted hydrogen (Thiorhodaceæ, differing therefore from sulphur-bacteria in the need for light) or of organic compounds (Athiorhodaceæ). Similarly the organism responsible for methane production reduces carbon dioxide in the presence of hydrogen, propionic bacteria reduce carbon dioxide during the fermentation of glycerol and other substrates, and the anærobic spore former (Clostridium sp.) isolated by Wieringa in 1936 synthesizes acetic acid from carbon dioxide with gaseous hydrogen as the sole reducing agent. There has been sporadic mention of the fact that carbon dioxide is necessary in small amounts for the development of a number of heterotrophic bacteria, for yeast and for other fungi some of which can be stimulated to more rapid growth in the presence of carbon dioxide at concentrations higher than in normal air. Consideration of the facts relating to pigmented cells led van Niel to propose a generalized formula for photosynthesis:

$$2H_2A + CO_2 = (CH_2O) + H_2O + 2A,$$

the hydrogen donor being considered as water in green plants (substantiated by Ruben *et al.* in 1941 using heavy oxygen), sulphuretted hydrogen in green bacteria, sulphuretted hydrogen and other reduced sulphur compounds for purple sulphur bacteria, and an analogous formula would seem to apply to most carbon dioxide reductions by organisms. Thus *B. coli* contains an enzyme 'hydrogenlyase' which catalyses the reaction

$$HCOOH \rightarrow CO_2 + H_2.$$

Another organism catalyses the same reaction but reunites the gases to form methane under the influence of 'hydrogenase'. In this it resembles the classical methane fermentation and here, according to van Niel, the hydrogen comes from any oxidizable organic substrate acting as hydrogen donor, with the general relation

$$4H_2A + CO_2 = 4A + CH_4 + 2H_2O.$$

This and other systems are examined briefly in the review.

In the bulk of these cases the overall metabolism is such that a net uptake of carbon dioxide occurs. The situation in the case of heterotrophic organisms is complicated by the fact that a net *production* occurs. These have now been investigated using radioactive carbon, and a number of tissues and organisms of different physiological types, both plant and animal, are now known to absorb carbon dioxide. It is finally pointed out that the application of this new method to normal photosynthesis in green plants proves carbon dioxide to be absorbed in darkness, and has suggested that the first intermediate in the photosynthetic process is a large molecule (mol. wt. approx. 1,000) with a free $-$COOH and an $\alpha -$OH. This is conceived as an enzyme or its prosthetic group and suggests that the following reaction occurs:

$$RH + CO_2 \rightarrow RCOOH:$$
$$RCOOH + H_2O + h\nu \rightarrow RCH_2OH + O_2.$$

RCH_2OH adds another carbon dioxide and the process continues until long carbohydrate chains are built up and split off as starch or soluble sugars.

GRASS AS HUMAN FOOD

IN normal agricultural economy the main role of the farm animal is to convert coarse vegetable foodstuffs into palatable and readily digested meat and dairy products. In war-time the value of this function must be reviewed in relation to the exigencies of the shipping situation, and the gain in quality in foodstuffs of animal origin must be balanced against the great loss in quantity which must inevitably occur during the conversion. Some peace-time practices, such as the liberal use of wheat in feeding poultry, are obviously out of place during war-time. It is difficult, however, to forecast what degree of success could be attained in a frontal attack on the position of the farm animal, in which the aim would be to make part of the vast food resources of green pasture directly available for human consumption.

The main objection to the use of grass as a major component of the human diet lies in its high content of cellulose. Since the water content is high, a large bulk would have to be taken to make a significant contribution to the daily calorie requirement, and the undigested residue would prove an intolerable strain on the capabilities of the human intestine. Two distinct possibilities for the use of grass may, however, be recognized. (1) The manufacture of concentrates, free from cellulose, which might be eaten freely as substitutes for meat and cheese. Most of the vitamins would presumably be separated during this procedure, and could be worked up as a by-product. (2) The direct consumption, in salads or otherwise, of small amounts of young tender herbage. This dietary innovation would be valued as a source of vitamins, rather than as a serious contribution to the protein or energy requirements of the body.

In a pamphlet "Eating for Victory", a sequel to "Grass for All", Mr. J. R. B. Branson describes his personal experience of a vegetarian diet containing moderate amounts of fresh or dried grass (Branson's Publications, Headley Mill Farm, Bordon, Hants. 4*d*.). At the ripe age of sixty-eight, he reports a remarkable physical and spiritual rejuvenation, and describes the performance of tests of physical endurance which were possibly more arduous than scientific. In his opinion the beneficial properties of grass may be related to its chlorophyll content, and reference is made to the experiments of Prof. Buergi of the University of Berne. It may be recalled that this work is frequently quoted in advertisements in the popular Press in support of the supposed rejuvenating properties of a commercial preparation of this pigment.

While it is very doubtful indeed whether authentic medical opinion would support the view that chlorophyll has any real therapeutic virtue, it is possible that Mr. Branson may have benefited from the high vitamin content of his unusual diet. To those who might be persuaded to take advantage of the numerous recipes for the use of grass which he has propounded, we would repeat with emphasis his own advice of *festina lente*. Even small amounts of grass might prove injurious to digestive organs less robust than those of Mr. Branson. The injudicious ingestion of amounts made possible by the zeal of an ardent food reformer might easily give rise to intestinal obstruction, which would certainly be serious and possibly fatal.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, JULY 19

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the London Branch of the Institute of Physics) (at 49 Cromwell Road, London, S.W.7), at 2.30 p.m.—Discussion on Thunderstorm Problems.

FRIDAY, JULY 25

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. Sydney Chapman, F.R.S.: "Chree and his Work on Geomagnetism; Geomagnetic Time Relationships; and The Future of World Magnetic Surveying" (First Charles Chree Address).*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

FIVE ASSISTANTS (MALE OR FEMALE) IN AGRICULTURAL ECONOMICS, ONE (MALE OR FEMALE) ASSISTANT AGRICULTURAL ANALYST and TWO ASSISTANT FIELD MEN (MALE OR FEMALE)—The Agricultural Officer, Department of Agriculture and Horticulture, The University, Bristol (July 26).

LECTURER IN CHEMISTRY (GRADE IIA)—The Secretary, The University, Edmund Street, Birmingham 3 (July 31).

ASSISTANT ENGINEER TO THE MUNICIPAL COMMISSIONERS OF GEORGE TOWN, PENANG—Messrs. Peirce and Williams, 1 Victoria Street, London, S.W.1 (July 31).

PRINCIPAL of the Oldham Municipal Technical College—The Director of Education, Education Offices, Oldham (August 9).

DOMESTIC SCIENCE MISTRESS of the Girls' Intermediate School, Omdurman—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (endorsed 'Girls' Intermediate School).

REPORTS AND OTHER PUBLICATIONS

Great Britain and Ireland

Eire: Roinn Talmhaidheachta (Department of Agriculture), Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1939, 1937, 1935, 1933, 1931, 1929, 1927. (P. No. 4658.) Pp. 20. (Dublin: Stationery Office.) 6*d*. [266

Jealott's Hill Research Station. Bulletin No. 2: Culture of Plants in Sand and in Solutions. By W. G. Templeman. Pp. 28. (Bracknell: Imperial Chemical Industries, Ltd.) [17

Other Countries

Brooklyn Botanic Garden Record. Vol. 30, No. 2: Thirtieth Annual Report of the Brooklyn Botanic Garden, 1940. Pp. iv+37-190. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [256

U.S. Department of Agriculture. Circular No. 593: Apparatus and Technique for the Study of the Egg Parasites of the Beet Leafhopper. By Chas. F. Henderson. Pp. 19. 5 cents. Farmers' Bulletin No. 1866: Wireworms and their Control on Irrigated Lands. By M. C. Lane. Pp. ii+22. 10 cents. Technical Bulletin 743: Experiments with *Trichogramma minutum* Riley as a Control of the Sugarcane Borer in Louisiana. By H. A. Jaynes and E. K. Bynum. Pp. 43. 10 cents. Technical Bulletin No. 744: Life History of the Sugar-Beet Wireworm in Southern California. By M. W. Stone. Pp. 88. 15 cents. Technical Bulletin No. 758: Selenium Occurrence in Certain Soils in the United States, with a Discussion of Related Topics—Fifth Report. By K. T. Williams, H. W. Lakin and H. G. Byers. Pp. 70. 15 cents. (Washington, D.C.: Government Printing Office.) [256

Royal Observatory, Hong Kong. Upper Temperatures and the Properties of Air Masses over Hong Kong. (Appendix B to Hong Kong Meteorological Results, 1940.) By G. S. P. Heywood, under the direction of C. W. Jeffries. Pp. 14+5 plates. (Hong Kong: Royal Observatory.) 2 dollars. [266

Fifty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1939-1940. Pp. 10. (Washington, D.C.: Government Printing Office.) [266

Newfoundland Government: Department of Natural Resources. Research Bulletin No. 11: The Newfoundland Lobster Fishery: an Account of Statistics, Methods and Important Laws. By Dr. W. Templeman. Pp. 42. (St. John's: Department of Natural Resources.) 20 cents. [17

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NATURE

SATURDAY
JULY 26, 1941

THE FRATERNITY OF SCIENCE

THE early years of the twentieth century saw a recrudescence of the movement towards international intercourse in science. The natural philosophers of previous centuries, so far as they were free to carry on their studies, enjoyed a peculiar individual licence to visit and maintain communication with their brethren in other lands. With the growth of science itself, those associated with it began to band themselves together for the more frequent discussion of the many topics in which they were interested, and it was natural that such groups, at first local, should with the improvement of communications become national in scope. The national bodies continued to maintain a limited amount of intercourse by the exchange of publications and by the election of distinguished men of science as foreign members, but this in turn became inadequate to meet the needs of the rising tempo of scientific discovery and its applications. Thus were born the international associations, with regular meetings held at intervals of a year or more, attended by individuals and delegate bodies, and with international secretariats to transact their business during the intervals between successive meetings.

Into this healthily growing international intercourse of scientific men was injected the Nazi claim for 'Aryan science' and for 'Nordic superiority' in science as in other fields, followed by the exclusion from the calling of science of all who could not prove their purity of 'Nordic blood'. The result is well known to readers of NATURE. Everyone can recall how, in his own particular field, first one, then another distinguished figure, sometimes men of international repute, was forced to leave Germany, often in a state bordering on destitution.

It is worth while examining again the beginnings of this state of affairs. Dr. Julian Huxley traces in brief but telling fashion the rise and decay of science in Germany in a recent pamphlet "Argument of Blood"*. From the fifteenth century onward, the Germanic peoples have made noteworthy contributions to science ; as examples of

* Argument of Blood : the Advancement of Science. By Julian Huxley. (Macmillan War Pamphlets, No. 11.) Pp. 48. (London : Macmillan and Co., Ltd., 1941.) 3*d*. net.

outstanding men Dr. Huxley mentions Albrecht Dürer, Kepler, von Guericke, Leibniz, Goethe, Fraunhofer, Gauss, of the earlier period, and Liebig, Bunsen, Kirchhoff, Abbe, Koch, Ehrlich, Hertz, and Caro, Graebe and Libermann of more recent times. Nevertheless, science was later in achieving organized form in Germany than in England, France or Italy. With the opening of the nineteenth century, however, the modern German university system began to develop under the ægis, and with the aid of, the State, and the attention given to science led, by the middle of the century, to the German university institutions becoming the accepted homes for schools of scientific research built up by the university professors, to which flocked students from other parts of Europe and from the United States. All this time, however, the State retained its hold on the universities, and was able to ensure that research did not lose touch with industrial development.

Incidentally, Dr. Huxley points out that a very substantial part was taken by Jews in this development of science and its applications. Although they formed only about 1 per cent of the population, it is estimated that they have been responsible for some 25 per cent of significant German contributions to science. German anti-Jewish outbursts, Dr. Huxley suggests, may thus be in part a symptom of an inferiority complex.

Their mode of development will account for the difference in outlook between German university institutions and those of Great Britain. The State has always exercised a degree of control which, with the rise of National Socialism, enabled the Nazi Party quickly to abolish all freedom of study. Dr. Huxley refers in particular to events in the Universities of Heidelberg and Göttingen. By 1936, he says, all serious instruction in philosophy at Heidelberg had ceased, and nearly half the staff in that faculty had been dismissed; appointments were being made on political grounds. At Göttingen similar changes were made; within a year, nearly a quarter of the University staff had been dismissed.

Such drastic changes in the university system of Germany were bound to have repercussions on the output of scientific research as regards both quality and quantity. The former is difficult to assess, but the correspondence columns of NATURE will serve as a criterion of the latter. Here it was noticeable that the number of original contributions to science coming from German institutions quickly decreased: allowance must, however, be made for the fact that support in NATURE for a policy of intellectual freedom had brought the journal into disfavour. Dr. Huxley points out that the deterioration in quality has been most marked in mathematics, physics and pure biology; whereas in a subject of direct military value, such as aircraft engineering, a number of valuable contributions to knowledge has been made.

Both staff and students were affected by the changes imposed by the Nazi regime. Although it is difficult to obtain statistics relating to university education in the years immediately preceding the War, it is known from the records of societies assisting displaced intellectuals that nearly 2,000 university teachers were dismissed; many posts were filled with 'safe' Party men, but others were discontinued. As a result, the university teacher lost that security of tenure which hitherto had left him free to pursue his investigations and to teach the truth as he found it without regard to political considerations. The effects on the student body were even more striking. The number of students was reduced to nearly one half of what it was before the Nazis assumed power. Military and semi-military studies were given greater prominence, while the course for medical students was reduced by two years. Another innovation, doubtless made in pursuance of the search for 'leaders' who would be both docile to central Nazi control and also sufficiently immature to be fanatical in their adherence to the new regime, was to appoint student bodies under Party guidance and led by students who in some cases were placed outside the jurisdiction of the university authorities. Normal university life was deliberately undermined.

Apart from these direct attacks on learning, one of the most sinister undertakings of the Nazis has been the deliberate distortion of truth, undertaken with the view of providing a seemingly scientific basis for National Socialist ideology. Dr. Huxley very fittingly deals with the so-called 'racial biology', which is taught from the elementary schools upwards. By a profusion of literature, by lectures and by all the guile of propaganda, the superiority of the 'Aryan', 'Nordic' or 'German' race has been drummed into the minds of a generation who have never been allowed to hear its fallacies discussed. It will be a difficult but essential task to undo this work in the years to come.

With all this coercion and suppression of scientific effort, it is not apparent at first glance why Nazi Germany has been able to make such efficient use of scientific and engineering developments for waging war. The answer Dr. Huxley gives—and it will be generally accepted—is that Nazi success has been based on the large store of technical knowledge and the numerous skilled men trained on scientific principles still remaining in Germany; time will reduce their number and make their training out of date.

So much for effects within Germany itself of

the suppression of freedom of learning. Sir Richard Gregory, president for the duration of the War of the British Association, and formerly for many years editor of NATURE, takes up the tale at this point in "Science in Chains"*, and voices the feelings of men of science outside Germany, who have observed, at first with concern and later with horror, the cramping restrictions imposed on research and the barbaric discipline which have followed in the wake of Nazism.

An early hint of the attitude of the Nazi Party to scientific intercourse was seen in 1934 at the meeting in Berne of the Astronomische Gesellschaft, a body which, though German in origin, is strongly international in character. One of the secretaries was a Jew, and the German delegates to the meeting were ordered to exclude him, and any other Jewish astronomer, from office. The attempt failed, but it conveyed a warning as to the character of German delegations which would attend scientific meetings outside Germany. Indeed, in 1935, by order of the Minister of Propaganda, all representation at congresses, inside or outside Germany, was put under the control of a Science Congress Centre, on the specious excuse as regards foreign travel that lack of foreign currency made such centralization necessary. Further, all who went abroad for purposes of study or to give lectures were required to report themselves to the local German representative and to the Foreign Organization of the Nazi Party. The object of these regulations was immediately obvious: they were to ensure that only politically 'safe' spokesmen would be allowed to interpret scientific developments in Germany to the outside world. Under such conditions there can be no adequate exchange of scientific views, and science degenerates into an instrument of national aggrandizement.

This intellectual blight, as Sir Richard Gregory terms it, has descended on every country which has come under Nazi control. With the occupation of Czechoslovakia in 1939, all scientific work had to cease; institutes were closed, and equipment was destroyed or transferred to Germany. Similar measures were taken in Poland, and some of the ancient universities of Holland have suffered. There should be no need to enlarge upon such instances of Nazi repression as it affects science, for many have been recorded in NATURE during the past two years.

What has been the reaction of the world of science to this reversal of the whole trend of scientific intercourse? An early movement was the formation of a body, now known as the Society for the Protection of Science and Learning, to help intellectual workers who have been deprived of their means of livelihood for racial or political reasons. This body has done magnificent work in providing for many such refugees the opportunity of continuing their vocation, and thus has preserved for civilization the intellectual powers of a considerable body of men. Another effect, perhaps slow to gather strength, was the appearance of protests in the scientific Press; these protests were at first cautious, for scientific men did not care to risk the charge of interfering with what might at first appear to be the internal affairs of another country. One result of such protests was, as readers of NATURE will recall, that this journal was "excluded from general use in scientific libraries" in Germany; it will be noted that the journal was not entirely banned, for apparently it was still of service, and incidentally, as Sir Richard Gregory points out, German publishers continued, until the outbreak of war, to send scientific works to NATURE and other responsible British journals, confident that they would be justly appraised and the reviews accepted by scientific colleagues all over the world.

Another stage in the growing volume of protest was marked by a resolution passed in 1938 by the American Association for the Advancement of Science, in which the democratic principles of science and the need for intellectual freedom in research were strongly urged. "We regard the suppression of thought and of its free expression as a major crime against civilization itself." Since then, the American Association has asked the British Association to collaborate in framing a charter of democracy on scientific principles, and as a first step towards such collaboration, the Division for the Social and International Relations of Science of the British Association has formulated a statement of the democratic fellowship of science.

Freedom of thought and freedom of communication between the scientific workers of all countries are essential to the progress of humanity. Any political system which challenges these cardinal principles threatens the very life-blood of science; whatever temporary successes it may achieve by tapping existing reservoirs of knowledge and skill, it contains within itself the seeds of decay. Sir Richard Gregory rightly says: "Science would be false to its tradition if it failed to protest against such criminal assaults on the human mind. Its spirit cannot be confined within any national or racial boundaries, and its service cannot be monopolised by any single country, without debasing the principles for which it has always stood. To make race, political convictions, or religious faith, barriers to the pursuit of natural knowledge, means that science in Nazi Germany loses its soul for the purpose of gaining the world."

* Science in Chains. By Sir Richard Gregory. (Macmillan War Pamphlets, No. 12.) Pp. 32. (London: Macmillan and Co., Ltd., 1941.) 3*d*. net.

INDUSTRIAL CHEMICAL ANALYSIS

Lunge and Keane's Technical Methods of Chemical Analysis

Second edition, edited by Dr. Charles A. Keane and Dr. P. C. L. Thorne. Vol. 4. Pp. xv+963. (London and Edinburgh: Gurney and Jackson, 1940.) 84s. net.

IN the years immediately succeeding the War of 1914–18, British chemical industry underwent a renaissance the chief features of which included the intensification of research both by individual firms and by the newly constituted research associations, the rationalization of industry, and the formation of merged companies. In many cases products and processes of manufacture were standardized. Methods of testing were reviewed and modernized and new analytical technique developed to keep pace with the ever-increasing range of new products.

Many of these new developments are reflected in the new edition of Lunge and Keane's standard work on "Technical Methods of Chemical Analysis", the fourth volume of which deals in two large sections with textiles and textile chemistry and with coal tar and tar products; there are, in addition, relatively smaller but equally important sections on coal gas, ammoniacal liquor, explosives, matches and fireworks and on calcium carbide and acetylene. It is essential in a work of this description that the subject-matter should be beyond reproach, and the authenticity of the details in Vol. 4 is guaranteed by the high professional status of the authors of the various sections.

In present circumstances, two of the smaller sections, namely those on explosives and on calcium carbide and acetylene, make a most opportune appearance. The manufacture of explosives must always remain a highly specialized industry in which the most extreme precautions are necessary to ensure not only the safety of the workers but also the stability of the manufactured product. In normal times this manufacture is carried out by a relatively small number of skilled technicians, and the use of explosive material is largely restricted to the engineering profession. War conditions, however, necessitate a very large increase in the number of those engaged on the manufacture, handling and safe storage of these dangerous materials, and the detailed tests described by Prof. O'Reilly not only of the raw materials used but also of the finished products will be of the utmost value to both the technical chemist and the authorities on whom rests the responsibility for the operation of adequate safety measures.

Almost all gas welding operations require acetylene, for which calcium carbide is the necessary basis. A very large expansion in the manufacture of this important industrial gas takes place therefore during times of war, when all branches of engineering operate under high pressure. The details of the tests necessary in the production of acetylene come from the authoritative pen of Mr. C. Coulson Smith, of the British Oxygen Co., Ltd., which hitherto has been almost wholly responsible for this manufacture in Great Britain. The author does not concern himself primarily with any test relative to the production of carbide but devotes himself to those tests required for the examination of the finished carbide and of the acetylene derived therefrom. Particular attention is given to the tests for phosphorus impurities, which are suspected of being the cause of some acetylene explosions. These detailed tests are most timely in view of the increased number of chemists, engineers and other technicians now engaged in this important industry, and assume greater significance in view of the industrial importance of acetylene derivatives such as cyanamide, thiourea, melamine and the vinyl polymers.

The staff of the South Metropolitan Gas Co. are responsible, through Mr. H. D. Greenwood and Mr. P. Parrish respectively, for the sections on coal gas and ammoniacal liquor and ammonium salts. The description of modern methods of analysis in the coal gas industry is noteworthy for the information on the evaluation of refractories and the methods of control during carbonization. As an illustration of the original work always proceeding in the laboratories of the gas undertakings, there is a very clear account of the comparatively recent brilliant research work carried out by H. Hollings and his colleagues of the Gas Light and Coke Company leading to the elimination of gum formation in coal gas.

Many of the new developments in the British chemical industry noted at the outset of this review are to be found in the history of the coal tar industry during the past twenty years. Of all the raw materials of industry, coal tar occupies a unique position, being on one hand a by-product of one major industry—coal carbonization—and on the other the starting material for a whole range of other important manufactures. The general

economics of this raw material are based on the profitable marketing of several well-known fractions such as benzole, naphthas, creosote, cresylic acid, anthracene oil and pitch. To these must be added a surprisingly small list of pure constituents, chiefly benzene, toluene, naphthalene and anthracene, together with phenol, the three cresols and pyridine. Although it was possible for any organization, deriving its tar from a given source, almost to standardize its products, there was obviously much variation in the fractions produced by different organizations, and discrepancies were accentuated by the introduction of new varieties of tar, in particular vertical retort tar. It was realized, therefore, shortly after the War of 1914–18, that the time was ripe for standardization of products throughout the tar industry. Rationalization was carried out by the formation of several large groups, which together with the already powerful tar organizations of the metropolitan gas undertakings, formed the Association of Tar Distillers. This Association, working through several expert committees, proceeded to review and select satisfactory tests for tar products, finally publishing a volume entitled "Standard Methods for Testing Tar and its Products", to the mutual benefit of producers and consumers. The work of these committees provided a shining example of the pooling of general knowledge, and "Standard Methods" crystallizes the accumulated experience of many organizations over a long period.

The 1938 edition of "Standard Methods" forms the basis of the large section on coal tar and tar products contributed to Lunge and Keane's treatise by Mr. A. McCulloch and Mr. R. Murdin Drake. The authors, however, have not restricted themselves to the British standards, but also include some of those accepted in the United States of America and in some cases in Germany. This section, therefore, is most comprehensive and includes, in addition to the technical tests, much general information with respect to the production and utilization of tar and tar products. It is unusual but useful to find descriptions of the tests employed, for example, of the disinfectants and insecticides made from tar products. The authors have also drawn on the results of research carried out, notably by the National Benzole Association and the British Road Tar Association. This latter organization is responsible for much original investigation in the evaluation and improvement of prepared tars, particularly for road construction work, which absorbs by far the largest proportion of the tar produced in Great Britain.

This comprehensive section represents the most up-to-date evaluation of coal tar and its products to be found in any book and will form the standard reference work for all those engaged either in the distillation or in utilization of tar products. Whereas the reader of this section cannot fail to be impressed by the very thorough manner in which the tar industry has standardized the tests for its products, he may on reflection wonder why so few of the many constituents of this material are isolated in a pure condition. Admittedly, the entities described are those for which there is a ready demand, but one hopes that this well-organized industry will develop technique whereby lesser-known but potentially valuable components such as β-methyl naphthalene, higher aromatic hydrocarbons such as pyrene, together with the individual xylenols, or even higher phenols may be isolated and their uses developed.

Of the many trade research associations which were initiated in collaboration with the Department of Scientific and Industrial Research, two of the most successful were those connected with the cotton and wool industries. The results of investigations carried out by these organizations were quickly adopted by industry, with the result that many new processes for the treatment and testing of textiles were developed. How widespread has been the expansion in the technique of textile chemistry may be judged by the fact that no less than 280 pages of the new edition of Lunge and Keane, as compared with only 140 in the old edition, are devoted to the description of the various tests now applied in the manufacture and examination of textile fabrics, including the rayons, which have been wholly developed since the period covered by the first edition of this treatise.

The whole section on textiles and textile chemistry has been prepared under the general supervision of Mr. J. M. Preston, of the College of Technology, Manchester, the sub-sections having been prepared by a team of experts. A wide range of information hitherto not to be found within the bounds of one book has been collected, arranged and presented in the logical sequence of: physical and chemical tests of textile fibres and fabrics, tests for dyestuffs, auxiliaries and detergents used in the industry and finally tests for finishes and their defects.

Few, except those directly engaged in the industry, can be aware of the many tests applied to ensure that high standard now expected of and maintained by the textile industry. Microscopical, chemical and mechanical tests are regularly used throughout all the stages of aggregation met with during manufacture, from that of the single fibre to that obtaining in the finished article. In addition, the auxiliaries such as wetting agents and soaps are subjected to rigorous examination, while the testing of dyestuffs, particularly as regards fastness, forms a whole field of chemical technology

itself. Each of these series of tests requires a highly skilled and specialized staff to whom the details of tests applied in the branches of the industry other than their own will be most useful. To those outside the textile industry, the last subsection on the examination of textiles after finishing probably holds most interest. In the past twenty years permanence of colour and finish have been greatly improved and many new finishes introduced, eighteen of which are described in this subsection. As an example, there is the development of the use of synthetic resins, particularly urea-formaldehyde, to yield a fabric with increased resistance to creasing, and the use of formaldehyde in conjunction with an aliphatic amide to produce resistance to wetting.

A book on technical methods of analysis might be considered by the superficial inquirer to furnish rather arid reading except to those experts directly interested, but in this volume the reader will find much of the romance of chemical industry. Many of the new processes and products which have now become familiar names are here described in an accurate, scientific and readable manner to whet the interest and excite the imagination of the reader. Of primary interest to technicians, and written with the object of defining the various tests applied in the selected industries, the book forms a mirror of the achievements of these industries during the past thirty years, and shows once more that there is no finality in chemistry.

D. D. PRATT.

PREPARATION OF ORES FOR METALLURGICAL TREATMENT

(1) Textbook of Ore Dressing

By Prof. Robert H. Richards and Prof. Charles E. Locke, assisted by Prof. Reinhardt Schuhmann, Jr. Third edition, completely revised and rewritten. Pp. xiii+608. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 36s.

(2) Principles of Mineral Dressing

By Prof. A. M. Gaudin. Pp. xi+554. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 33s.

THE maintenance of the present standard of living of civilized man is dependent upon an adequate supply of metals, without which conditions would return to those of the Stone Age. The production and preparation of food, clothing, transport and other necessities all depend fundamentally upon the provision of the requisite tools. These tools are largely made from metals, and to cover wastage and also expansion in the use of mechanical aids fresh supplies have to be made available continuously.

The use of non-ferrous metal in the arts has so increased in the last hundred years that it is unlikely that there are undiscovered any rich, readily accessible sources from which losses can be made good. Luckily the supplies of iron and coal are still more than adequate to meet all needs in normal times. But man cannot live by iron alone, and other metals have to be provided.

The mineral deposits that are being worked to-day, as distinct from those worked in earlier times, nearly always consist of complicated mixtures of valuable ores and worthless gangue which have to be separated. Further, the individual ores have to be segregated from each other and collected in the form of concentrates. This process is known to mining and metallurgical engineers as 'dressing', a word which occurs in the titles of both books under review.

The term 'dressing' in each case is used to indicate the separation by physical means as distinct from metallurgical treatment in which chemical reactions are employed. Many and varied advances in science and engineering are employed in modern dressing, and in a single book it is impossible to discuss every known principle and practice in use.

It is interesting to recall that up to thirty years ago simple processing by water concentration accounted for 90 per cent of the world's output of non-ferrous metals, whereas to-day, except for alluvial workings, it accounts for less than 10 per cent. Its place has been taken by the froth flotation process: the separation of minerals from one another in a froth by virtue of difference in their surface tension. Up to 1924 the main application of the frothing process consisted of bulk flotation of sulphides in an acid circuit using oils of various kinds as reagents, whereas to-day, selective or differential flotation is the common practice using organic or inorganic chemicals in an alkaline circuit. No solution has, however, yet been obtained to the problem of floating oxides such as cassiterite, which would prove a boon to the Cornish mining industry.

The publication of two new text-books by well-known writers on the subject is always a matter

of interest, and there is an additional piquancy when it is realized that the authors are both members of the Faculty of Mining Engineering at the same institution at Massachusetts.

The method of treatment of the subject-matter is widely different and yet the two books might be considered complementary. Locke's text-book is a welcome and long overdue revision of Richard's standard work, whereas Gaudin's is new and is compiled, as he says, largely from his lecture notes and research activities. It is impossible for the two books not to overlap, but in general it can be said that they cater for different types of readers. Locke will appeal to the works operator, the man who wants to know *how* to do something, whereas Gaudin will be of more assistance to those who wish to know primarily *why* a process works. Broadly, one describes modern practice and the other the principles underlying modern practice, but includes an exceptionally good bibliography of the subject.

Both books follow the conventional lay-out in that, chapter by chapter, they discuss the machines used in each stage of a mineral dressing plant, only differing in the emphasis placed upon the various items.

Thus, stage by stage, they cover the processes by which the crude product of a mine is broken to a sufficient degree of fineness to release the valuable ore from unwanted minerals and then describe various methods employed to collect it.

Both books should be in the library of all metalliferous mining engineers and, in the case of Locke, of coal miners also, because one chapter is devoted to a discussion of the equally important subject of coal cleaning. J. A. S. RITSON.

A GENERALIZATION OF ABELIAN INTEGRALS

The Theory and Applications of Harmonic Integrals
By Prof. W. V. D. Hodge. Pp. ix+281. (Cambridge: At the University Press, 1941.) 12*s*. net.

PROF. HODGE's work on this subject has long been awaited by his colleagues, and will be generally welcomed by them, though perhaps with mixed feelings when its difficulty is encountered. His lectures and papers have already given some idea of the scope the work would have, as well as of the origin of the line of research of which this book is the first important monument. It is in effect an attempt to generalize in a very wide way that aspect of the study of functions (such as Abelian integrals) on a Riemann surface which consists in treating the real and imaginary parts separately, and adjoining to the integrability condition a second differential condition which ensures that the two functions considered are in fact the real and imaginary parts of an analytic function. (This latter we may call the orthogonality condition.) The place of the Riemann surface is taken by a 'Riemannian manifold' of any number of dimensions; this is continuous and has ordinary differential geometry in the small, with metric, affine connexion, and Riemann-Christoffel tensor; while in the large it is a two-sided or orientable space, to which the ordinary combinatory topology applies, with Betti numbers, torsions and intersection matrices.

The first chapter is devoted to recapitulation of these two theories. The second develops the idea of a p-fold integral, and the differential form associated with it, and includes the generalization of Green's and Stokes's theorems, in virtue of which we have first-order differential conditions for integrability, to ensure that the value or 'period' of the integral over homologous cycles is the same; the chapter ends with de Rahm's proof of the existence of an integral with assigned periods on all linearly independent p-cycles. In this no use is made of the metric; but the next chapter defines a harmonic integral as one which satisfies not only the integrability conditions, but also a second set of first-order differential conditions, depending on the metric, and analogous to the orthogonality condition in the simple case; the coefficients in a form which satisfies both conditions may be compared to the components of a vector the curl and divergence of which both vanish. Hodge's own proof then follows of the existence of a unique harmonic integral having assigned periods.

The remaining two chapters are devoted to the applications of the foregoing theory to algebraic geometry, and to the theory of continuous groups. The former (presumably the *raison d'être* of the whole investigation) are, as the author says, isolated, and may at first sight appear somewhat meagre. The bulk of the labour in this chapter is devoted to sorting out which of the harmonic integrals are in fact the real and imaginary parts of algebraic integrals; the metric in the Riemannian manifold of $2m$ dimensions (which represents the complex points of an m-dimensional algebraic variety just as the Riemann surface does those of an algebraic curve) is not invariant, and its possible trans-

formations are not even confined to be conformal, as in the case $m=1$; so that the theory of harmonic integrals contains, in a sense, a good deal of lumber which must be cleared away before the genuine applications to obtain algebraic-geometric results can be made. The definition of the geometric genus in terms of the signature of an intersection matrix, published some years ago for surfaces and here generalized, is however a triumph which would have justified a far more laborious analysis, even had it been the only result; and the conditions, in terms of vanishing of periods, for a cycle to be algebraic (that is, to be the image on the Riemannian of some algebraic sub-variety on the original variety), though apparently not completely worked out as regards their sufficiency, look as if they might lead to results of great value. The theory is of course in its infancy, and it is hard to say yet how far it may take us; its chief lack so far, if it is to achieve a comparable power and importance with the classical theory for curves, seems to be anything like a generalization of Abel's theorem; and it is hard to see what form such a result could be expected to take. The applications to continuous groups seem to consist mainly of new proofs of known results, but here again it is early to say what may be achieved.

The whole book is exceedingly difficult to read—a difficulty which is partly inherent in the subject, but which one feels also is somewhat characteristic of the author. The style is very dry and severe; the summaries of previous work are too brief and formal to be readily understood unless the reader is already fairly familiar with the work in question; little time is spared for pointing out the purpose of the steps taken, or of the definitions introduced; and the notation (which is necessarily very intricate) has not always been selected with sufficient care to avoid confusion—thus on p. 160 i is in one equation a dummy suffix over which summation takes place, and the square root of -1, and there are other pitfalls of the same kind, though less glaring. The printing on the other hand seems admirable, and in all that complicated jungle of formulæ I have not detected one misprint. PATRICK DU VAL.

STEAM, AIR AND GAS POWER

Steam, Air and Gas Power
By Prof. William H. Severns and Prof. Howard E. Degler. Third edition. Pp. vii+511. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 24*s*. net.

WHEN a book such as this has reached its third edition it may be taken for granted that it possesses in high measure those qualities which go to the making of a standard work. Progress in heat engines during recent years has been considerable, but provided the method of exposition of the fundamental principles is sound and the attitude of the author to his subject is a correct one, the main structure of the work will readily carry such new developments, either in theory or in practice, as take place between one edition and another. To this category then it may be said that the present book belongs, for while in large measure keeping pace with progress in heat-power engineering it retains the excellent mode of presentation which has characterized its earlier editions.

Some developments, however, have not received the attention they deserve. In the chapter on steam generators, mention is made of high pressure and of critical pressure steam generation, but there is no reference to the La Mont and Loeffler boilers, which are now fully established types. Their respective principles of operation and details of construction are essential to the present-day student of steam power, to which it may be said that the book gives a disproportionately large space.

Dealing first with general principles, the authors pass on to describe and elucidate the extensive range of equipment which goes to form a complete steam plant. Feed-water, its treatment and heating, chimneys, draught and fans, reciprocating engines and turbines, condensers and pumps are adequately dealt with, and there is a useful chapter on steam-engine power and economy.

Air compression, compressors and engines receive treatment compatible with the importance of the use of air as a source of power in such special cases as in deep mines, where it gives three advantages—its transmission for long distances without great loss, the cooling effect of its exhaust and its help in ventilation. It can scarcely be said, however, that the internal combustion engine has been dealt with as fully as its importance and variety deserve. Apart, however, from this criticism it should be pointed out that the theoretical and practical aspects of this section of the subject have been excellently presented, and the student will receive a good grounding, particularly in the fuels available and their combustion.

An Introduction to Astronomy

By Prof. Robert H. Baker. Second edition. Pp. viii+315. (New York: D. Van Nostrand Co.; London: Macmillan and Co., Ltd., 1940.) 12*s.* 6*d.* net.

THE first edition of this work appeared in 1935, and there have been two reprints since. The second edition follows the general plan of the earlier edition, but a few minor alterations have been made to clarify certain points and various new features have been introduced to bring the work into line with astronomical progress. Two chapters, "The Galactic System" and "The Exterior Systems", have been rewritten owing to the recent rapid developments in these spheres, and of course Satellites X and XI are now included among Jupiter's satellites.

The book commences with the usual aspects of the earth and the sky and then deals with the solar system, the stars, nebulæ and galactic systems. Chapter v contains an excellent description of the constellations with a number of maps and charts which will prove very helpful to those who are commencing a study of the stars in the different seasons. A very important feature of the work is the list of questions which are given at the end of each chapter. These have a direct bearing on the subject dealt with in the chapter and they will make students realize that careful reading is necessary if the text is to be thoroughly understood. Probably many will find it expedient to re-read each chapter to answer the questions satisfactorily, and this will ensure a good foundation in the various branches which are considered. The large number of diagrams and photographs adds considerably to the usefulness of this book.

M. D.

The Francis Walker Types of Trichoptera in the British Museum

Re-described and figured by Dr. Cornelius Betten and Martin E. Mosely. Pp. x+248. (London: British Museum [Natural History], 1940.) 15*s.*

THE descriptions of Trichoptera or caddis flies, made by Francis Walker nearly a hundred years ago, have proved quite inadequate guides to their recognition. It has become increasingly difficult with the lapse of time to associate Walker's descriptions with species now established upon modern conceptions involving the use of more fundamental characters than colour, wing-pattern and the like. Walker's descriptions, however, have formed the basis for all subsequent work on American Trichoptera, since very few of the species had, in his day, been previously named. With the growth of subsequent knowledge much confusion of synonymy has resulted, and the joint authors of this work have made use of their opportunity to clarify the position for the future. They have re-described not only all the North American species, which occupy the greater part of the volume, but have also done likewise for all other recognizable Walkerian species of the order. Accompanying the descriptions are many excellent figures of the genitalia, and of the venation in cases where needed. The work has been well carried out by authors and publishers alike.

Fundamentals of Photography

With Laboratory Experiments. By Prof. Paul E. Boucher. Pp. xi+304+lii. (London: Chapman and Hall, Ltd., 1941.) 16*s.* net.

THIS book is another welcome piece of evidence of the growth of systematic teaching of photography in universities of the United States. It concentrates on the need for exact knowledge of the technique of photography, which requires experimental work as well as reading. The treatment is best illustrated by the author's definition of a good photograph as one which gives correct tone reproduction. The pictorial side is, however, equally fundamental, and a considerable proportion of students taking such a course will apply their knowledge later to work in which this plays an important part. However, the pictorial part must be largely self-taught and, if correct technique is not learned first, the odds are that it never will be.

The book loses some coherence by its order and arrangement. The camera is discussed before lenses and image formation. Developers are dealt with in Chapter ii; development in Chapter vii and again separately for negatives, contact prints, enlargements and lantern slides. The experimental section is excellent and forms a serious investigation of how photography works. It will probably be many years before any university in Great Britain provides the apparatus and facilities for such a course.

The book will then be valuable as a text-book for both teachers and students. There are few errors, but aberrations are described as 'defects in lenses' and the greater tone range made possible by slide projection is explained incorrectly. Reflex cameras are said to be popular among pressmen; the contrary is true in Great Britain and most users of reflexes are agreed that they are unsuited to speed work. The book is reasonably priced but the illustration is poor.

A. S. C. L.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1941. Edited by Dr. M. Epstein. Seventy-eighth annual publication: revised after Official Returns. Pp. xxxvi+1487. (London: Macmillan and Co., Ltd., 1941.) 20*s.* net.

IN spite of obvious difficulties this valuable annual makes its usual appearance and has not shrunk in size. The States of Europe and the rest of the world appear as they were before the War, and in those that have been the victims of Nazi onslaught statistics have to be confined to an earlier year than last. For the rest the figures have been revised so far as official returns permit, and the book presents a summary of current prevailing political and economic conditions for most of the world. The introductory tables of world production of various commodities are most useful. Two coloured maps show respectively naval and air-bases leased by Great Britain to the United States and the boundaries of Rumania as they were up to September 1940. It is noteworthy that the price of the volume has not been increased.

FUNGI IN RELATION TO MAN*

By Dr. J. Ramsbottom, O.B.E.,
British Museum (Natural History)

Fungi as Food

MOST people in Great Britain would classify the numerous fungi of our woods and fields into two groups, the first including one species, the mushroom (*Psalliota campestris*) which is edible, the other including the rest which are called toadstools and are labelled poisonous. Those who have eaten abroad with a true spirit of gastronomic adventure know that certain toadstools make an attractive dish and even in London continue to sample cèpes (various species of Boletus), morel, chanterelle and truffle. This list, however, can be much extended, and forty or fifty species are far more delicate in flavour than the field mushroom of which, moreover, certain of the wild forms are much superior to those usually cultivated. Formerly, several species were sold in Covent Garden market, and blewits, blue-leg or blue stalks (*Tricholoma personatum*) is still sold in the north-east, midlands and west, though round about Berwick-on-Tweed it is now bought by dyers for the extracting of a blue dye, the price offered being two shillings a stone; it would be wiser to eat them than to sell them at this price.

In these days of war, no one could accuse our diet of lacking experiment. Even so, if one suggested that toadstools might be added, there would probably be an outcry about the great danger of poisoning. The fact, however, is that very few of those that anyone would think of cooking are even suspect. But one wholesome-looking species, *Amanita phalloides*, is not only deadly poisonous, but also causes intensive and extensive agonies. One or two allied species such as *Amanita mappa* are usually considered dangerous, but it may be that there has been confusion in identity. The best-known poisonous toadstool is the fly agaric (*Amanita muscaria*) with its scarlet, white-spotted cap, which makes it the most pictured and modelled of all fungi. Here the effects are not deadly though they are severe. The remaining poisonous fungi which grow in Great Britain can be counted on one's fingers and their characters could be learned by any ordinary person with little trouble.

The food value of fungi is not very high if we judge merely by calories, but they serve as an attractive addition to meals or as flavouring and have, moreover, a vitamin content, B and D, and sometimes A, which is appreciable. To purchase cultivated mushrooms at their present exorbitant price is uneconomical for anyone having to consider either food values or his purse, but there is no reason why in rural districts there should not be some organized scheme by which information could be given about edible fungi and various methods of cooking them; they might even be sold in local markets. A little confidence but not rash experiment is all that is needed.

It is strange that in Europe and North America only the field mushroom is cultivated and this by a method which apparently originated in France in the seventeenth century. Attempts have been made to cultivate truffles and other fungi on a large scale but without success. The Chinese and Japanese have cultivated shiitake, an edible fungus, on logs, for more than two thousand years, and in all tropical countries a species of Volvaria may be said to be cultivated, for special beds are prepared for its growth though there is no inoculation.

Parasitic and Saprophytic Fungi

Before it was recognized towards the end of the seventies of last century that bacteria are the main cause of certain diseases, it was known with some certainty that fungi occurred in association with diseases such as ring-worm and were usually regarded as causing them. A century ago, about the time when many of these fungi were first recognized, it was more customary than not to regard what we know now as a parasitic organism not as the cause of a disease but as the result of it. The penetration of one organism by another, with the resulting disease, and the spread of the contagion was first clearly recognized by Bassi, who after long years of research on the muscardine of silk worms showed that it was due to a mould now usually known as *Botrytis Bassiana*. It is difficult to realize that this work was published only a year before Queen Victoria came to the throne. During the following forty years there was as much advance in our knowledge of the nature of disease as there has been in the last forty years in methods of locomotion. There were many false starts and one of these was a tendency to regard all contagious human diseases as due to fungi. However, the true path was shown by a host of investigators whose names are prominent in the history of bacteriology, and the fungi were

* Substance of a Chadwick Public Lecture, entitled "The Interrelation of Man and Fungus in Health and Disease", delivered at the Chelsea Physic Garden on June 19.

gradually relegated to a minor position, though in Great Britain the pendulum has swung too far.

The commonest fungi which affect man are the members of the ring-worm group, some attacking the heads of children, others causing eczema-like eruptions on the skin; a frequent focus for the last type is between the fingers or toes, the usual pathogen then being *Epidermophyton interdigitale*. Infection of the feet by this or allied forms has become more common during the last few years, apparently being picked up on the recently popular sea cruises or in public or school baths, where bare feet encounter contaminated woodwork. The throat trouble 'thrush' is still occasionally troublesome in babies owing to the use of dirty feeding-bottles, but even women of the poorest classes have learned sufficient about hygiene to reduce materially the prevalence of this disease.

An important point about the majority of these mycological diseases is that they are due to fungi which can live either normally or secondarily as saprophytes. Thus *Oidium albicans*, the fungus of 'thrush', occurs in sour milk, and ring-worm fungi affecting cattle have been found growing also on the dung in the byre. The phenomenon is not surprising, having regard to its known frequency with disease-producing bacteria, but it is often overlooked. Not only man but also his ox and his ass are subject to occasional fungal infections, and birds and fish have also a few mycological diseases. Insects are very frequently attacked, one large family (Laboulbeniales) being confined to them as hosts and numerous genera are peculiar to certain insects. Attempts have been made to control insect pests by infecting them with their special fungus parasite.

The most important and numerous diseases caused by fungi are, however, those of plants. Though there are bacterial diseases of plants and also virus diseases, they are few compared with those due to fungi.

Although diseases of crops have been recognized since the earliest times—indeed it would be well-nigh impossible for them to have been overlooked—the urban population of to-day has little idea of the loss that occurs even when every civilized country has its phytopathological service. Estimates of the losses due to fungal disease have been published from time to time. Many of the older estimates refer to years when the losses were exceptional, but modern figures show what enormous losses occur every year. Thus it has been calculated that in the United States more than £10,000,000 is lost in an average year by stem-rust of wheat, whereas it may be five or six times that amount in a bad year; bunt takes an average toll of £2,500,000 and loose smut nearly £1,000,000—and these are not the only diseases which affect wheat, nor is the United States exceptional in the severity of these diseases. The losses in the main crops of the United States are estimated as ranging from two to fifty per cent; 200,000,000 bushels of maize, for example, are lost annually. The figures for world losses are astounding. The downy mildew of the vine has been estimated as causing an annual loss of £500,000,000. The classical example of what a fungus disease can do at its worst was shown a century ago by the potato disease. This disease spread all over Europe causing devastation and dismay. It afflicted Ireland, causing a famine which wrecked a British Cabinet and produced other political and economic effects the results of which are still apparent.

Disease also takes its toll of forest trees. Of the disease-producing organisms fungi are usually the more prominent. The large bracket fungi growing on the boles or roots of trees are for the most part wound parasites requiring some break or crack before they can gain entrance. The result of such an attack is generally a rotting of the heart wood. As the defect occurs in unworked wood it is known as 'wet rot', as opposed to 'dry rot' of worked wood. It should be obvious that the tree trunks which have been so attacked are in a state in which further decay can occur in certain conditions, but sometimes it is the practice merely to remove the parts which are visibly affected. But the filaments of a rot-producing fungus do not stop dead in their progress at the point where their destructive action is apparent, but have usually extended beyond this. Different fungi behave somewhat differently, and it is only a broad general outline that can be mentioned here, and that mainly to stress that care must be taken to ensure that timber affected by wet rot is entirely rid of mycelium before use for structural purposes, or alternatively that it is stored and afterwards used in conditions which do not permit the fungus to renew its growth.

A certain amount of decay takes place in timber yards and there are well-proved practices to reduce this to a minimum. What I have said about the possible continued presence of the mycelium of wet-rot fungi is important, for it is wood stored for use that is affected. Proper sanitation and aeration are the best preventives.

But, from the aspect we are considering, rot in worked wood, that is dry rot, is much more important. There are several kinds of dry rot, but by far the most destructive, the most widespread and the most abundant is that due to *Merulius lacrymans*. Strange to say, this fungus is confined to buildings. An outdoor form has been described, but it is very rare and of no consequence except

taxonomically. It would be difficult to overstress the amount of damage caused in buildings and the ease with which this could be prevented. Wherever there is imperfectly seasoned or damp wood with insufficient ventilation the fungus is almost certain to appear, sooner or later. Having got a start it is able to spread, passing by strands over or through substances from which it cannot obtain nutriment and devouring other woodwork with which it meets. Attacked wood is reduced to powder. Water is formed from the breaking down of the substance of the wood, and this enables the fungus to continue its growth. Excess water is exuded from the fungus as drops, which explains the scientific name of the fungus but puzzles many whose sole knowledge is that their house is said to be suffering from dry rot.

When the strands of Merulius cannot proceed farther they form fruit bodies with an olive-orange coloured honeycomb-like surface. These fruit bodies produce millions of millions of microscopic orange-coloured spores. A fruit-body a foot across, no unusual size, produces more than enough spores to infect every building in the British Isles. Frequently they form a layer on furniture and other objects in a house and often cause alarm where no other effect of the fungus had been noticed. I once had an egg sent to me which was almost wholly orange-coloured, and was able to assure the sender that there was nothing wrong with it but that the cellar where it had been kept was badly in need of attention.

It is well to stress the subject of dry rot at the present time. After the War of 1914–18, when there was a renewal of building, the prevalence of dry rot in some of the building estates was astounding. With proper ventilation and sound seasoned timber there need be no fear after this War of a repetition of the losses of the last building boom, but if precautions are not taken the damage resulting from dry rot will doubtless be even greater.

Not only food plants but also all food may be subject to fungal attack. Mouldiness is one of the commonest phenomena of everyday life, but it is not universally recognized that moulds are living organisms. Moreover, in common with other organisms, they have certain requisites for growth: they need certain food substances, a certain range of temperature and a certain amount of moisture.

The fact that moulds grow only between certain temperatures is acted on in our methods of preservation; preservation, broadly speaking, is the prevention of the deterioration brought about by fungi or bacteria. If food is kept below a given temperature moulds which can grow only at temperatures above this remain dormant. This is the basis of cold storage. There are many problems of cold storage, particularly with fruit, but these do not alter the general principles.

Not all fungi are incapable of growth at the low temperature at which chilled meat is transported and occasionally there is trouble from these, as, for example, in black spot (Cladosporium), white spot (Sporotrichum) and whiskers (Mucor and Thamnidium). It is noteworthy that *Merulius lacrymans* often occurs in cold storage plant and in refrigerator cars.

Freezing does not ensure the killing of the fungi but only that they are unable to grow, and in growing cause damage. Indeed the spores of many common moulds when dried can be taken down to the temperature of liquid hydrogen without loss of vitality, and are able to withstand the rarefied air, intense cold and blazing sunlight of the stratosphere.

When cold-store meat, fruit and other food is released for use, it is not, therefore, in a sterilized condition; so far as moulds are concerned, it is more or less in the same state as when it went into storage. The only practical method of sterilizing food is by heat, and to keep it sterilized all organisms must be kept out of contact with it or, as we say, no air should be allowed to get to it.

The spread of knowledge about infectious diseases in recent years has opened the eyes of the general public to the widespread occurrence of germs invisible to the naked eye. Invisible fungus spores, of all kinds, are also present in the air in prodigious numbers and have been shown to occur at a height of several miles. Moulds appear with such consistency on foodstuffs and other organic substances that formerly it was commonly thought that putrescence was universal and inevitable and that moulds are the consequence of the decay. It was partly because of this that the similar view about plant diseases was prevalent.

It may be truthfully said that it would be exceptional for any organic material which was not thoroughly dry to escape decay and destruction. Heat is the only safe sterilizer. The temperature needed is higher than is theoretically sufficient because many spores have highly resistant walls which the heat must penetrate to be effective. Sterilization is the basis of the procedure in fruit-bottling, and similar methods of fruit preservation. But obviously so soon as sterilized material is exposed to the air, so soon is it liable to reinfection. Some foods are more readily attacked by mould than are others; moisture has a good deal to do with this, especially if the food is enclosed. Thus biscuits if kept in a dry place, either in a tin or on a plate, will remain wholesome, whereas bread, especially when cut, will soon become mouldy in a bread pan, though not so quickly if left free to

the air, but fortunately the time taken is too long for it to affect ordinary household procedure in normal times.

This necessity for moisture was early discovered in man's efforts to preserve his foods, and 'sun-drying' is still practised with numerous fruits. Until 1924, when there was a Government Committee report on the subject, it had become the practice to add such substances as benzoic acid, boric acid and formaldehyde to various foods as preservatives. All these are harmful to some extent and their use was prohibited, except that it is permissible to add small quantities of antiseptics such as sulphurous acid to fruit juices or meat products.

Apart from some chemical solutions which are poisonous to fungi, there are many others in which ordinary moulds will not grow. For this reason fats and oils, vinegar and strong sugar solutions have their use in preserving food.

USE OF FUNGI

We should be more happy without parasites, at least those which affect us, our animals and the plants we use. But what if there were no saprophytes living on dead material? What if there were no decay and no decomposition?

In natural conditions, decay, paradoxical as it may sound, is a method of sanitation. As things are, we are dependent upon plants with chlorophyll for our existence and equally upon organisms without chlorophyll—the ones to build up organic structures, the others to remove them when life is ended. To take a single example. A forest floor as the trees grow is covered with leaves which are later turned into leaf-mould or soil. As the years pass and a tree's span of life is reached it dies and falls or breaks, or it may succumb to the attacks of parasites. Saprophytic fungi grow on the fallen log or broken stump and gradually, over the years, it is reduced to pulp and finally this is also added to the soil. This has gone on through the ages and to such effect that a primeval forest from this aspect looks very little different from a reasonably old plantation, though forestry sanitation demands that there the fallen trees and broken branches should be removed. But this natural removal of fallen trees, leaves, fruits, shrubs, herbs, as well as dead animals, is carried out by fungi and bacteria living saprophytically.

It is perhaps only in places where man congregates—villages, towns and cities—that there is real danger to himself from putrescent material. If he waits until it disappears by what we may call natural means, then there may result those epidemics which hygiene and sanitary science have taught us to expect.

In the centuries man has discovered that not all the effects of fungal activity result in making wholesome food and drink distasteful or poisonous. Every race has its fermented liquors. Most of these fermentations are brought about by yeasts which act on the sugar present in fruits, cereals, plant juices and such like with the production of alcohol. The infection of the yeasts was haphazard, and with experience some degree of certainty about the resulting products was attained. With increasing knowledge of the biological processes involved in the operations it has become possible to control some of the fermentations so that the same species is used under the same conditions with a more or less standard result. The best understood of these is the production of different kinds of beer, but similar scientific methods have been applied, though not so commonly, in the making of wine and cider. Also it is realized that there are diseases of beer and other beverages which are brought about by the growth of alien organisms.

The raising of dough by yeasts in bread-making and the ripening of rennet cheeses by Penicillium are now often controlled in the strictest manner. Many moulds have been found to be responsible for products which are desirable for various purposes. Sometimes this may be a new substance or it may be one profitable to produce by fermentation. As an example of the second is the production of citric acid by *Aspergillus niger*, a common and abundant mould. Until a few years ago, lemons were used for this purpose, but the fungus is so efficient that it is used even in Italy, formerly the chief source of the acid—and incidentally one which would not be available to us at present.

There are many other products which the study of fungus activity has made available in industry. When the biochemistry of fungi is more fully understood, we shall have the means of producing with ease many substances difficult to synthesize without their aid, and many as yet unknown substances which will have their uses. The achievements of the past give promise that the attempts to harness some of the activities of the organisms will be profitable.

Just as the fungus known as ergot, which causes a disease of rye and other cereals and which when eaten in bread brings about gangrene or convulsions, has so important a place in modern medicine that it is listed in the Medical Research Council's recent memorandum on drugs the production of which in the United Kingdom should be encouraged, so may we hope that eventually we may benefit by turning what at first sight appears unmitigated evil into something beneficial to mankind.

A RECORD OF THE CHANGING FACE OF BRITAIN

BY DR. VAUGHAN CORNISH

THE Committee for the Employment of Artists in War-time, supported by a grant from the Pilgrim Trust, has co-ordinated the work of landscape painters in recording (mostly in water-colour) the architectural gems of rural England with the background of their natural setting. The pictures now on view in the National Gallery, a selection of the first year's work, are arranged according to counties. Such pictures should be multiplied year by year until a complete collection has been made which can be housed for permanent exhibition.

The value of the collection now begun is both historical and educational. The former has, of course, to do with the possible loss of these objects of beauty. This loss may occur in one or other of two ways—destruction by the Huns in war-time, or replanning by Vandals in the succeeding years of peace.

The educational value of this new collection of pictures is especially important in relation to the period of replanning and reconditioning. Whether England's beauty will then be restored or obliterated will depend not only on the accident of individual talent in architecture and administration, but also on the wider diffusion of artistic culture which will ensure that public opinion will not mistake the aberrations of bad taste for the originality of genius.

As we look through the present collection in the National Gallery we find that the subjects recorded as of local or period interest include indoor as well as outdoor scenes of rural architecture—timbered roofs and the paraphernalia of the mills which grind the corn we grow.

The exterior of a windmill is shown in the picture of Dolce Mill, Rochester, by Thomas Hennell. Looking upon this, it is easy to realize the imaginative impression of a four-armed giant which led Don Quixote to emulate the achievement of legendary knights.

The villages and small country towns of Buckinghamshire are charmingly illustrated by Stanley Anderson, R.A.; in Beaconsfield the architectural features surrounding a *place* (for which we have no English name altogether equivalent); in Amersham an interesting Market Hall; and in Long Crendon an old house with the outside chimney shaft which was a picturesque addition to rural architecture at an early date.

The view of Chesham, Bucks, by W. P. Robins, is a landscape proper in which the church spire and neighbouring cottages are minor, decorative features nestling in a well-timbered valley below tree-capped hills.

The street of Hadleigh, by A. Newton, shows the timbered houses with overhanging upper story, which are characteristic of a Suffolk village.

An excellent example of architecture with natural background is seen in Charles Knight's picture of a Sussex farmstead at the foot of the bold slopes of the open chalk downs. Birdham Mill, by W. Russell Flint, R.A., shows a picturesque building set amidst the winding waters of Chichester Channel, a remote corner of Sussex.

Among the line drawings, of which there are a few among the many water-colours, that by S. R. Badmin of a bridge over the Ouse at Chellington, in Bedfordshire, records one of the numerous survivals of medieval arches, the beauty of which is often enhanced by reflexion in the placid streams of the English lowland.

Of buildings in the north of England, the picture of Livesay Hall, in Lancashire, by W. Fairclough, shows an unusually complete preservation of stone-mullioned windows, which are too often replaced by modern woodwork out of harmony with stone fabric.

The market-place of Thame, in Oxfordshire, by Stanley Anderson, R.A., is depicted, as is proper, on market day; for without the gathering of countrymen the picture of a market-place is one of form without function.

From Gloucestershire we have the double dovecote of Coln St. Aldwyn, by George Bissell, an example of the Cotswold style which is a blessed survival of one of the best types of English rural architecture.

A number of interesting examples of the architecture of south-western England are shown in the distinctive water-colours of S. S. Longley: in Dorsetshire the village of Corfe, and the Saxon church of Wareham, which stands in a remarkable position above the sunken road which enters that ancient town. In Devon we have Brixham, with its houses on a steep slope above the little harbour where lies the fishing fleet amidst the reflexions of lapping waves which come gently in from the broad waters of Tor Bay.

Lastly, we come to Longley's simple but charming water-colour of the old farmhouse of Thorn in Salcombe Regis, near Sidmouth, which takes its name from the historic Thorn Tree, close at hand, renewed again and again since Saxon times, and it may even be from yet earlier days.

DIRECT PETROL INJECTION *versus* THE CARBURETTOR FOR THE INTERNAL COMBUSTION ENGINE

REPLYING to the debate upon aircraft supply in the House of Commons, on July 10, the Minister of Aircraft Production, Lieut.-Colonel Moore-Brabazon, mentioned that where the British aero engine industry uses the carburettor, the Germans have adopted the fuel injection system. The use of direct fuel injection, as an alternative to the carburettor of spark-ignition aero-engines, is put forward in some quarters as a cure for the many shortcomings of the carburettor engine, and, in particular, as a means of improved performance at altitude. The injection may be made either before the entry to the supercharger, into the induction manifold, or directly into the engine cylinders. The German systems inject direct into the cylinders, which, having regard to the all-round advantages of the three methods, is probably the best position.

The claims to superiority of the injection system as compared with the carburettor are as follows:

(1) No restriction is offered to the free 'breathing' of the engine, because the pressure drop necessarily incurred at the venturi of the carburettor (and not recovered) is eliminated. This pressure drop is about 1 in. of mercury at ground-level and increases with altitude if the air-flow is constant, because of the fall in air density. It is only significant at altitudes above the 'rated' or full-throttle height. If the venturi is made larger, so as to reduce the 'throttling' at high altitudes, the pressure drop available for fuel metering may be inconveniently small at lower altitudes. Further, eliminating the carburettor gives a clearer entry for the air into the supercharger. The total effect, above the rated altitude, is to increase the height at which a given boost pressure, and therefore power output, is available, and hence to improve the ceiling of the aircraft. It should be noted, however, that the beneficial effect of fuel cooling, in increasing the pressure ratio of the supercharger, is lost, a factor tending to outweigh the gain conferred by reduced restriction to the air-flow. The disadvantage of a low metering pressure can be eliminated by using a 'blown' or pressure carburettor after the supercharger.

(2) The induction system is freed from the hazard of 'refrigeration' icing, because the effect of evaporative fuel cooling is absent. This is a very real advantage as compared with the now obsolescent unheated carburettor, but carburettors are available which are immune from freezing trouble.

(3) There is superior fuel economy due to perfect distribution to individual cylinders. It should be noted that the air distribution is, however, unaffected. Comparative tests indicate that there is little difference in economy between the carburettor and the injection system, at least at normal air temperature. It is possible, however, that at high altitudes, when it is known that distribution becomes poor, the injection system may score. Alternatively, fuel of lower volatility may be used, although it is understood that fuel taken from German tanks indicates that no reduction in knock-rating is being made.

(4) Freedom from inertia effects. This is a definite advantage during fighting manœuvring, but it applies only to the float-type carburettor. Pressure-injection carburettors are available which are equally unaffected by altitude or acceleration.

(5) Reduced risk of vapour-lock at high altitudes, due to the absence of fuel pressure drops in the system and the accompanying risk of vapour evolution. The injection pumps themselves are susceptible to vapour and air in the fuel supply and the Germans fit de-aerators to deal with this risk.

(6) The injection system would be essential for a two-stroke cycle engine in order to eliminate fuel waste during the scavenge period, unavoidable with a carburettor.

It appears that, on balance, the injection system, as compared with many present carburettors, has some slight but definite advantages. Against these must be set the extra complication of the fuel pump and nozzle, and the high standard of accuracy essential to their production and maintenance. This latter question is not without its importance under war conditions. The Junkers system comprises 1,576 parts, 327 being different, and weighs 60 lb., as compared with the Rolls Royce Merlin's 433 parts, 141 being different, and weighing 25 lb. There is also likely to be a definite speed limitation to the injection pump, whereas no such limitation applies to the carburettor.

OBITUARIES

Sir Arthur Evans, F.R.S.

ARTHUR JOHN EVANS was born on July 8, 1851, at Nash Mills, Hemel Hempstead, Herts. The son of John Evans (afterwards Sir John Evans, K.C.B.), the most eminent prehistoric archæologist of his day, he was educated at Harrow and Brasenose College, Oxford, where he took first-class honours in history. It was not, however, formal education that played the most important part in the development of his mind. From his earliest years his surroundings were a training for his future career. In 1859 John Evans was appointed one of a committee of three which crossed to France to pronounce on the origin of the worked flints which Boucher de Perthes had discovered in the valley of the Somme and had claimed to be the earliest known tools and weapons of man; and his home and the great collections of antiquities of the stone, bronze, iron and later ages, which he was then forming, were the centre of the discussions on early man and the earliest evidences of human handiwork in which Sir John Lubbock (afterwards Lord Avebury), Sir Charles Lyell, Boyd Dawkins and others were taking part with him in the earlier years of the latter half of the nineteenth century.

If this atmosphere of archæological discussion played its part in determining the bent of Arthur Evans's intellectual development, no less important was his familiarity with his father's vast collections. There he derived that flair in handling antiquities which gave him an almost uncanny judgment in analysing the formative influences which pointed to their cultural derivation and constituted his great strength in the constructive interpretation of the evidence which he won from archæological sites with the spade of the excavator.

As an archæologist, Arthur Evans was interested in the development of form rather than in the study of the technical processes of production in which his father had excelled. His attention mainly turned in the direction of the bronze and iron ages, the latter then little known in Britain, rather than to the stone age. It was this interest in form which, when he had been for some years a fellow of Brasenose College, Oxford, especially fitted him for his appointment as keeper of the Ashmolean Museum. This post he held from 1884 until 1908, when he became honorary keeper.

Evans's fame as the excavator of Knossos and the discoverer in Crete of the bronze age civilization of the Mediterranean has tended to obscure the eminence of his achievement in British archæology, but his account of his excavation of the iron age burial site at Aylesford in Kent will always be a classic of reference and of crucial importance for the study of the British iron age, while his research on the origins of Celtic art in Britain, which were summed up in his Rhind Lectures of 1895, unfortunately never published, had a fundamental and abiding effect on the future development of that branch of archæological investigation. This department of Evans's research, however, proved to be of even greater and more far-reaching significance, for it was this which first turned his attention in the direction of the Mediterranean and the investigation of the relation of the forms of the prehistoric culture of the Europe of north and west to that of the south and east, a subject to grow under the hands of Oskar Montelius, the Swedish archæologist, and George Coffey, of Dublin.

In carrying out his duties as keeper of the Ashmolean, Evans showed all that vigour, determination of character and capacity for organization which were afterwards to stand him in good stead as an archæological excavator. He organized that venerable institution and made it an integral part of the University. He also undertook archæological exploration in 1873–74 in Finland and Russia, and in the following years he paid the first of a series of visits to the Balkan peninsula.

Evans's early travels of the Balkans were of no little consequence in more directions than one. His experiences were embodied in a series of letters from Illyria to the *Manchester Guardian*, which afterwards appeared in book form, and were thought by some to contain much of his best work as an observer and man of letters. Here he showed acute powers of seizing the essentials of a situation at a time when tension between Italian and Slav under Austrian rule was rapidly attaining breaking point. Like most Westerns who visit the Balkans, Evans became a partisan. Convinced of the justice of the claims of the Slavs, who, though numerically vastly in the majority, had little voice in affairs, he actively espoused their cause, and in 1882 was thrown into prison by the Austrian authorities for his participation in the Crivoscian insurrection. He never lost his sympathy with the Slav, and during the War of 1914–18 he was one of the most active supporters of the movement which led to the formation of the kingdom of Yugoslavia.

In the early 'nineties, Evans began his archæological exploration of Crete. In part he was attracted by the possibility of finding evidence bearing on the origin of the alphabet and early forms of writing, and in 1893 his search was rewarded by the discovery of a pre-Phœnician script. But as time went on, the importance of the island in an archæological sense became increasingly apparent. The excavations of Schliemann at Troy, Mycenæ and Tiryns, which began in 1866 and had been continued on more scientific lines by Dorpfeld, as well as the work of other excavators which was being carried on at other sites in the eastern Mediterranean area, pointed to the existence of a previously unsuspected civilization which was not the Greece of the Homeric age, much less the inheritance of classical times. Evans's personal knowledge of Greece and the eastern

Mediterranean, and the general archæological situation, pointed in the direction of Crete as a strategical strong point; while Petrie's discoveries in Egypt in the later 'nineties demonstrated the existence as a menace to that kingdom in the eighteenth and nineteenth dynasties of some strong maritime confederacy to the north. As was soon to be shown, Evans's confidence and perseverance were justified. In 1900, at Knossos, he discovered the first traces of the Palace and the earliest evidence upon which he was to rear the structure of Minoan civilization, and, in conjunction with material brought by other archæologists, British, American, Greek, French, German, not only from Crete, but also from the mainland and Asia Minor, to reconstruct the whole of the forgotten bronze age culture of the Mediterranean.

From 1900 until 1908, Evans was engaged in the excavation of this site at Knossos, and year by year at meetings of the British Association, the Society of Antiquarians in London and elsewhere, as well as in the publications of the British School at Athens or the Hellenic Society, he reported on his discoveries. So far as was possible, preservation and reconstruction followed exploration, and in 1925 the site, which he had purchased, and the Palace, were handed over on a trust to the British School of Archæology at Athens as a museum and for purposes of archæological research.

At the close of his excavations, Evans had completed the tale of the whole bronze age, so far as revealed on the site at Knossos, covering a period of two thousand years or more and extending from neolithic times down to the final destruction of the Palace at the dawn of the iron age. It is true the one site did not always tell the story in full, but what was lacking was found on other sites of the island, Palækastro, Gournia, Messara, and so forth. Evans's achievement did not rest there, and it is largely due to his genius in interpretation and cultural analysis that we now know the relations of Crete with Egypt and North Africa, with the mainland and islands of Greece, with their Helladic culture, and Asia Minor, and can accept as well founded his reasoned conclusions as to the origins and the influences which built up this great prehistoric civilization.

The work of final analysis and exposition of the evidence from Knossos was long and arduous, and will in itself explain the fact that from 1900 onward, apart from contributions to the periodicals of learned societies, Evans's writings, though all important, were not great in bulk. Of these the most important or considerable are his "Tree and Pillar Cult" (1901) and his "Scripta Minoa" (1909). His account of the excavations as a whole was given to the world in four large volumes under the title "The Palace of Minos", of which the first appeared in 1922 and the fourth in 1935. The completion of the last volume was celebrated at the close of 1934 by Evans's friends and admirers, who presented to him a portrait bust (see NATURE, Dec. 22, 1934, p. 962).

Enough has already been said to make it unnecessary to attempt any further estimate of the value of Arthur Evans's contribution to archæological research. He added a whole chapter, and that one of the most important and crucial, to the history of civilization. From the year 1900 his work became fundamental in determining the course of all future research, not only in the Mediterranean area, but also in the whole region which has been the arena of development of modern civilization. It is perhaps not the least striking evidence of his force of character and strength of intellect that when he made his first discovery at Knossos, he had attained his fiftieth year, and at a time when most who have not already reached the highest attainment can scarcely hope to achieve eminence in a new field, he added to a reputation already established by an achievement second to none in modern archæological investigation.

Arthur Evans naturally and deservedly was the recipient of many honours. In 1911 he was knighted. He was a D.Litt. of Oxford, hon. LL.D. of Edinburgh and Dublin, and hon. Ph.D. of Berlin, a fellow of Brasenose College, Oxford, and fellow of the Society of Antiquaries of London, of which he was president 1914–19. In 1916 he was president of the British Association for the Advancement of Science, an office which he accepted with extreme reluctance, owing to what he felt to be the claim of national duty during the War. So long ago as 1901 he was elected to the Royal Society, which gave him its premier award, the Copley Medal, in 1936. He was awarded the Royal Gold Medal of the Institute of British Architects, the Petrie Medal for archæology, and was Frazer Lecturer in 1930. The more important Continental societies and academies which include archæology within their scope had recognized his work by honorary membership.

By the death of Sir Arthur Evans on July 11, only three days after celebrating his ninetieth birthday, following so closely on the death of Sir James Frazer, archæological and anthropological studies have lost two outstanding figures of international stature.

BOTH in the range of his learning and accomplishments, and in his positive contributions to knowledge, Sir Arthur Evans was an outstanding figure among nearly three generations of archæologists. He owed much to intimacy with his distinguished father, Sir John Evans, whom in some respects he closely resembled; much to the historian Edward Freeman, who encouraged him at Oxford; much to a year's study at Göttingen, to which he would refer with affection and gratitude.

But Evans's peculiar gifts were his own. His eyesight, though not seriously hampering him in field work, gave him a microscopic insight into the finest craftsmanship of gems and coins, enabling him to detect many minute signatures of ancient artists, and so to demonstrate the attribution of similar designs to the same hand. His remarkable flair for objects that interested him had already brought him treasures in other fields of exploration—Illyria and Sicily in particular—before he embarked in middle life on the Cretan adventures which made him known to a wider public.

His strong devotion to freedom and political

justice brought him into close relations with men of many nationalities and creeds, and gave him access to regions and communities which had been visited by few. His interest in the Southern Slavs and in the Cretans began while they were still dominated by the Turks, and he had the satisfaction of witnessing their liberation; it was indeed appropriate that the Yugoslav State and its Academy should be represented at his memorial service in Oxford. His genius for friendship, and for attracting devoted help from all classes made easy the conduct of archæological excavation on a very large scale, with the large private means which were as generously lavished on the Boy Scout Movement and other social services, as on his expeditions and collections.

Evans's beautiful home at Youlbury became a place of pilgrimage for colleagues from many lands, and a centre of wise counsel and unstinted help, especially to the younger workers. Few men so thoroughly enjoyed a full and strenuous life, or did more to enable others to do the same.

J. L. MYRES.

NEWS AND VIEWS

Reconstruction in Great Britain

IN a statement made in the House of Lords on July 17, Lord Reith, Minister of Works and Buildings, announced the publication of an interim report of the Uthwatt Committee, and stated that the Government is to take immediate steps to implement many of the recommendations. The Government is, of course, already committed to the principle of planning in redeveloping the country, but it is reassuring to learn that the Committee's recommendation that any action taken now to secure the orderly planning of areas which include substantially devastated sites must be planned as a whole, is to be accepted; and also that the further recommendation to have such areas defined is to be implemented as soon as the necessary legislation can be effected. The Committee has also recommended the setting up of a central authority to control building development by licence. On this point Lord Reith was not inclined to go so far; the Government view is that emergency powers over building are already stringent, and they have been reinforced by the control of payments made under the War Damage Act; further safeguards can be given by strengthening the Planning Acts.

The urgency of the problems of reconstruction appears to be now fully appreciated. Lord Reith stated that the Government agrees that all necessary preliminary steps for a national plan should be taken as soon as possible in order to ensure that local development shall be in harmony with national requirements. While Mr. Greenwood, Minister without Portfolio, is still to undertake the general study of post-war problems, Lord Reith is to have special responsibility for long-term planning policy in town and country in the sphere of physical reconstruction. To co-ordinate this work of forward planning with current administration, a Council of Ministers, consisting of the Secretary of State for Scotland, the Minister of Health, and Lord Reith (chairman), has been appointed. This Council of Ministers may prove to be the beginnings of the Central Planning Authority urged by the Uthwatt Committee, and indeed Lord Reith himself said he regarded it as having been established in embryo.

Russian Foreign Policy

THREE further Oxford Pamphlets on World Affairs are of particular interest in view of recent events. Miss Barbara Ward's "Russian Foreign Policy" (No. 34), while not dealing with events beyond the Finnish war, is of interest as an attempt to interpret Russian foreign policy free from ideological preconceptions, on the assumption that neither her problems nor her approach to them are in the last analysis very different from those of her neighbours. Miss Ward traces the foreign policy of the U.S.S.R. from the first year of its existence and its preoccupation with keeping its lands intact and its frontiers inviolate, through the failure of world revolution and the period of concentration upon economic contacts and peaceful diplomatic relations with the outside world, to Russia's entry into the European system of collective security. Obstacles to closer co-operation with the West and the influence of the Anti-Comintern Front are discussed as well as the events leading to the isolation of Russia, the Non-Aggression Pact with Germany and the Finnish war, and the underlying principle in Russian policy—security—is stressed.

Italian Foreign Policy

IN a further pamphlet (No. 48) Miss Ward attempts to place in their proper perspective the answers to such questions regarding Italian foreign policy as why Italy waited nine months before declaring war, and why she entered the war against old allies on the side of a hereditary enemy. Miss Ward indicates the consistency of Italy's policy, and states that the failures of her arms and diplomacy to-day were already predictable when she started her career as a great power some seventy years ago. Her reduction to colonial status as a dependency of the German Reich was always inherent in her policy of seeking aggrandizement without the military strength to secure it single-handed. Italy's humiliation will only be banished in a society in which great powers are no longer measured in colonial empire and military strength; in a fully organized European society of nations, Italy could play a leading part.

Holland and the War

This aspect is obviously of interest in relation to the question of European order on which Prof. G. N. Clark's pamphlet (No. 49, "Holland and the War") has an important bearing. Prof. Clark gives a picture of the economic position of Holland, her social structure and her constitution, and against this background describes her foreign policy in recent years and the circumstances under which she entered the War with her powerful material resources in the East Indies. He describes briefly the effects of the German occupation and Holland's aims in the War—a just and stable international order—and emphasizes the value of the freedom of the Netherlands to the civilization of the world. The preservation of that freedom, when restored, depends on the collective strength and wisdom of the friends of justice.

Carnegie United Kingdom Trust

The twenty-seventh annual report of the Carnegie United Kingdom Trust (Dunfermline: The Trust) covers the year 1940 and emphasizes the aim of its war-time policy to continue so far as possible to foster pioneer experimental work which may be expected to have an enduring effect on the social structure of the country. It also aims at safeguarding its own past work where this has proved to be of value by assisting earlier beneficiaries to maintain their services and, if necessary, extend them to meet special needs arising from the War. The year 1940 was the last year of a quinquennium, and the report briefly reviews the allocations made during that period. The largest single allocation was one of a £150,000 for land settlement schemes to be undertaken in England and Wales by the Land Settlement Association. The policy of this Association had to be completely re-orientated at the outbreak of war. At September 30, 1940, there were 1,054 holders on full-time estates, and the land has been brought under cultivation for production of corn, potatoes and other crops under schemes agreed with the county war agricultural committees. Individual grants to the National Council of Social Service have been rounded into a single block grant of £5,000 for 1940 to cover all those of the Council's activities in which the Trust is interested.

In the field of adult education, the main allocations during the period have been for the adaptation and equipment of Lord Lothian's gift of New Battle Abbey as a residential college for adult education and for two special inquiries into the problems of young people between the ages of eighteen and twenty-five. The preliminary area reports in the Age Group Enquiry reached an advanced stage of completion by the autumn of 1939, and the report covering the Cardiff district is being published independently under the auspices of the South Wales Council of Social Service and the Welsh University Press Board. The continued development of the Regional Library Bureaux presents the most interesting feature of library history of the last five years, and reference is made in the report to the assistance given to these Bureaux as well as to the National Central Library. Bulk allocations approved for 1941 include £8,000 to central libraries, £5,000 to the National Council of Social Service, £20,000 for youth services and £3,500 for land settlements. An immediate grant of £2,700 has been promised to the National Council of Girls Clubs to establish a bursary fund for training potential youth leaders and the salaries and expenses of supervisors of training. A grant of £2,000 for experiments in Oxfordshire on the establishment of a number of youth service camps has also been promised.

Acoustics of Argentine Chamber of Deputies

A description is given by S. D. Wilburn and S. C. Tenac in *Electrical Communication* (19, No. 3; 1941) of the system of microphones and loud-speakers designed by the Union Telefonica for the Argentine Chamber of Deputies in Buenos Aires and installed late in 1939. Investigation showed that the pronounced acoustical difficulties of the Chamber were due solely to the absence of reverberation. Structural alterations were not feasible and a system including a microphone for each individual had to be devised. The new system was first used officially at the opening session in 1940, and has given great satisfaction. It comprises 193 microphones and four loud-speakers in the Chamber. It has two independent channels of transmission: one with five microphones consisting of one each for the president of the Chamber of Deputies and the two secretaries and two on the ministers' table; the other channel is equipped for 188 individual-microphones for the deputies. The Chamber is completely surrounded by two walls with three-metre corridors between them at various heights. The four loud-speakers are located in the first gallery. A simple schematic circuit diagram of the transmission, switching and power circuits is given. The electric power consumption of the system is only 1·1 kilowatts.

Sylviculture of some Tropical Trees

To the forester versed in tropical forestry and who has had the opportunity of discussing sylvicultural problems with the mixed gathering found at an international forestry congress, perhaps the most interesting section in the *Malayan Forester* (January, 1941) is that in which observations are made on the sylvicultural characteristics of some of the important timber species. The coppicing powers of dipterocarp regeneration show that *Dryobalanops oblongifolia*, *Dipterocarpus Kerrii* and the balan and the white *meranti* groups of *Shorea* coppice fairly freely, while the red *merantis* and *merawan* (Hopea spp.) do not. There appears also to be some indication that ability to coppice and hardiness go together; for example, *Shorea ovalis* is one of the few red *merantis* to show some ability to coppice, whilst it has also shown itself more tolerant of transplanting than most of its group. How valuable are such practical notes is known only to those tropical foresters scattered about in India, Africa and elsewhere, who are dealing with similar problems with

valuable timber trees of the same genera or families, the knowledge of the secrets of the regeneration of which is absolutely vital to the work of replacing the often primeval stands he is dealing with.

It was the Indian forest officer (should we now say the Burman forest officer ?) who first studied the effects of firing the forest floor in the interests of obtaining successful regeneration of a valuable timber species. In Malaya preliminary investigations show that burning of the undergrowth is a prerequisite for the regeneration of *Melaleuca leucadendron*. An intentionally burnt area and one accidentally fired were equally successful in a covering of germinating seedlings; whilst an adjoining unburnt area appears to be as devoid of regeneration as ever. These practical observations in the forest (they cannot be undertaken in a research laboratory) are of the very greatest importance and of absorbing interest. In the case of the tropical forest they had their first beginnings in India, where a considerable amount of information had been collected by the end of last century. The present century has witnessed in some cases the results being put to a practical use.

Antarctic and Sub-Antarctic Starfishes

THE Asteroidea of the Sub-Antarctic and the Antarctic and a few from South Africa collected by the *Discovery*, *Discovery II* and the *William Scoresby* have been described by W. K. Fisher (Discovery Repts., 20; 1940). Seventeen new species and three new forms of previously described species are described. The author gives a critical list of all the valid species from the antarctic and sub-antarctic, which number 114. He himself deals with 113 different forms, not all separate species and not all from the main region, and from the number and wide range of specimens in some of them he is able to add considerably to our knowledge of these animals. The additional information thus gained has enabled him to revise certain groups. Thus the memoir is not merely a record of species obtained but also a noteworthy contribution to our understanding of the asteroids in southern latitudes. Perhaps the most interesting species is *Odinella nutrix*, which is the only known member of the Brisingidæ to possess a marsupium, and this is entirely different from that in any other group of starfish possessing brood chambers. The work is illustrated by twelve photographic plates and eighteen plates of figures.

Earthquake in Japan

DURING the night of July 16–17 a strong earthquake shook the northern part of the Nagano Prefecture, some 140 miles north-west of Tokyo. It is not yet known whether there were any casualties or not, but more than thirty houses collapsed and the railway between Nagano and Niigata Prefectures was interrupted for a short while. Japan is well known at present to be in a seismically active zone for earthquakes of all focal depths. Tremors, minor shocks and even strong earthquakes as in the case cited above are moderately frequent and very large earthquakes are by no means uncommon as, for example, the Kwanto earthquake of September 1, 1923, which nearly destroyed Tokyo and Yokohama, causing tremendous loss of property and the deaths of 250,000 people, the Tango earthquake of March 7, 1927, and the Idu earthquake of November 26, 1930.

Earthquakes Registered in Switzerland during 1939

THE complete bulletin of the Swiss Seismological Stations at Zurich, Chur, Neuchâtel, Basle and Sion for 1939, compiled by Dr. E. Wanner, has just been received. It contains, besides details of equipment, three tables and six maps. The first table and the maps concern earthquakes with epicentres in Switzerland, twenty-one of which were felt by people during 1939. The greatest intensity reached was five on the Rossi-Forel scale, this being on seven occasions: at Brig-Visp on May 18; at Martigny on August 23; at Unter-Engadin on September 26; at Aargau on November 17; at Sion Lokalstoh on November 20; at Oberes Baselbiet on December 5 and at Innerferrera on December 7. The second table contains a list of the details of ninety-one near earthquakes, whilst Table III contains a list with details of 178 distant earthquakes registered by the Swiss observatories during the year.

Max Jaffé (1841–1911)

PROF. MAX JAFFÉ, an eminent German biochemist and pathologist, was born at Grünberg in Silesia on July 25, 1841. He received his medical education in Berlin, where he qualified in 1862. While still a student he took a keen interest in chemical investigations and worked in the Pathological Laboratory under the direction of W. Kühne. During 1865–1872 he was an assistant in the medical clinic at Königsberg under Leyden, with whom he published a work on putrid sputum which led to the discovery of the spirilla and leptothrix characteristic of putrid processes in the lungs. In 1872 he was appointed extraordinary professor and in 1880 full professor of pharmacology and medical chemistry in the Königsberg faculty. His principal work consisted in the discovery of urobilin and urobilinogen in the urine and their origin in the bile, his studies of indican and creatinin, with the tests with which his name is associated, and his investigations in urocaninic acid in the urine of dogs and of ornithin in the excrement of birds. Jaffé had an extensive consultant practice and enjoyed a high reputation as a teacher. He died on October 26, 1911.

Armauer Hansen (1841–1912)

DR. GERHARD HENDRIK ARMAUER HANSEN, the celebrated Norwegian leprologist, was born at Bergen on July 29, 1841. He received his medical education at Christiania and qualified in 1866. Two years later he was appointed assistant physician to the leprosy home at Bergen under the direction of Dr. D. C. Danielssen, the founder of the scientific study of leprosy. In 1874 he read a paper before the Medical Society of Christiania, which was published in a

special number of the *Norsk Magazin for Laegevidenskaben* on the etiology of leprosy in which he demolished the theory of heredity, brought forward evidence in favour of its being a specific infectious disease, and described rod-like bodies in the lesions, which he afterwards named *B. lepræ* and regarded as the cause of the disease. His results were confirmed by Prof. Neisser of Breslau, who went to Bergen to examine Hansen's material. Hansen's contention that leprosy was an infectious disease was generally accepted, and led to laws being passed enforcing isolation and disinfection as in the case of other infectious diseases, with the result that the number of lepers in Norway showed a considerable diminution. Hansen received many honours, including the doctorate of the University of Copenhagen and the erection of his statue in the gardens of the Bergen Museum eleven years before his death, which took place on February 13, 1912.

Plastics

WE have received a copy of one of the Pelican Books entitled "Plastics", written by V. E. Yarsley and E. G. Couzens (Harmondsworth: Penguin Books, Ltd. Pp. 160+24 plates. *6d.*). This gives a very interesting account of the chemistry and physics of modern plastics and the methods of manufacture and the application of plastics. It is well illustrated and provided with an index.

The Night Sky in August

FULL moon occurs on August 7 at 5h. 38m. U.T. and new moon on August 22 at 18h. 34m. The moon is in conjunction with Mars on August 12, with Saturn on August 15, with Jupiter on August 17, and with Venus on August 25. At the beginning of the month Jupiter and Saturn are morning stars, their times of rising being soon after midnight and 23½h. respectively; at the end of August the times are approximately 22½h. and 21½h. The planets are easily recognized in the constellation of Taurus. Mercury rises at 3h. at the beginning and at 6h. 15m. at the end of the month and is in superior conjunction on August 19. Venus rises at 9h. and 7½h. approximately at the beginning and end of August and is in conjunction with Neptune on August 18. Mars is in the constellation of Pisces and rises shortly after 22h. at the beginning and at 20½ h. at the end of the month. The Perseid meteors reach their maximum on August 10–12, their radiant point being close to η Persei. The bright star α Tauri will be occulted by the moon on August 16d. 13h. 12m. approximately.

Announcements

THE George Cross has been awarded posthumously to the Earl of Suffolk, chief field research and experimental officer, Directorate of Scientific Research, Ministry of Supply, "for conspicuous bravery in connexion with bomb disposal". Lord Suffolk was the leader of a 'team' of three, the other two being Miss E. B. Morden (secretary) and Mr. F. W. Hards (mechanic), both of whom are commended for their work during the six months before they were killed.

LORD HAILEY has been appointed president of the Royal Central Asian Society, in succession to the late Lord Lloyd. The Lawrence of Arabia Memorial Medal has been awarded to Captain C. E. Corry, Iraq Police, author of "The Blood Feud", for his successful work in the tribal country of Iraq, and his study of the Marsh Arabs.

MR. J. P. R. RICHES, of Clare College, Cambridge, has been appointed to the Frank Smart studentship for research in botany for one year from October 1.

MISS D. F. BLEEK of Cape Town has been awarded the South African Medal and grant for the year 1940–41 by the South Africa Association for the Advancement of Science for her researches on the Bushmen, and is at present busy on her Bushman dictionary.

THE Jones-Bateman Cup for research in fruit-growing is offered triennially by the Royal Horticultural Society for original research in fruit culture which has added to our knowledge of cultivation, genetics, or other relative matters. The work dealt with should have been mainly carried out by the candidate in the United Kingdom, and mostly during the past five years. Candidates should submit accounts of their work by October 31.

THE following officers for 1941–42 of the Institution of Electrical Engineers have recently been elected: *President*, Sir Noel Ashbridge; *Vice-President*, Prof. S. Parker Smith; *Hon. Treasurer*, Mr. E. Leete.

THE Council of the Royal Society of Arts offers under the Thomas Gray Memorial Trust a prize of £50 to any person who may bring to its notice an invention, publication, diagram, etc., which in the opinion of the judges is considered to be an advancement in the science or practice of navigation, proposed or invented by himself in the period January 1. 1936—December 31, 1941. Competitors must forward their proofs of claim, between October 1 and December 31, to the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. In 1940 the Council offered a similar prize, which was awarded to Mr. H. C. Walker, of Cheam, Surrey, for a device known as the "portable valve lifeboat equipment", a self-contained radio auto-transmitter.

ON July 10, the honorary degree of LL.D. in the University of Aberdeen was conferred on the following: Dr. A. W. Falconer, principal and vice-chancellor of the University of Cape Town (*in absentia*); Prof. J. C. Philip, emeritus professor of physical chemistry in the Imperial College of Science and Technology, London, and president of the Chemical Society; Sir Alfred Zimmern, Montague Burton professor of international relations in the University of Oxford.

The ordinary degree of D.Sc. was conferred on F. Landgrebe, for a thesis entitled "A Comparative Study of the Autocoids of the Pituitary Gland", and on Dr. T. S. Westoll, for a thesis entitled "The Haplolepidæ: a New Family of late Carboniferous Bony Fishes".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Diffuse Spots in X-Ray Crystal Photographs

THE pattern of 'diffuse spots' in X-ray crystal photographs which has been recently the subject of much observation and discussion can, so far as has been examined, be calculated from the first principles of wave interference. It is the true diffraction pattern of the crystal lattice considered as a three-dimensional grating. Neither thermal conditions nor elastic properties enter into the calculations. I have discussed the case of sylvine in NATURE, 146, 50 (1940): I gave the results for diamond and calcite in the course of a discussion at the Royal Society on February 6, 1941; Preston's summary of the discussion appeared in NATURE, 147, 467 (1941). A more complete account of these comparisons of theory and experiment together with additional examples are in course of publication by the Royal Society.

Up to the present, the agreement between this true diffraction pattern and the observed effects is within the errors of experiment. Every observation finds its correlation in the pattern, though spots are not always observed where correlation could have been found. The correlation extends to such details as those that have been described by Mrs. Lonsdale for diamond (see accompanying letter), where the diffuse spots in some cases show curious extensions and in others break up into groups of smaller spots. Mrs. Lonsdale has recently found that the less common form of diamond, that which is especially transparent to infra-red and ultra-violet, does not present these minor details. In both cases the geometry of the observed pattern shows correlation with the true diffraction pattern so far as it goes: in one case it goes farther than in the other.

It is, of course, true that the effect calculated in this way ought to be far too weak to be observed in a perfect crystal composed of a considerable number of scattering centres as must be the case when the usual Laue pattern is observed. Why, then, is the true diffraction pattern observable after all? A satisfactory theory must answer this general question. It must account, among other things, for the diamond peculiarities.

W. H. BRAGG.

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Diffuse X-Ray Diffraction from the Two Types of Diamond

SIR Robert Robertson, Dr. J. J. Fox and Dr. A. E. Martin showed in 1934[1] that in addition to the normal type of diamond, which is always optically anisotropic, there is a rarer type which is much more nearly isotropic and which is more transparent both to infra-red and to ultra-violet radiation.

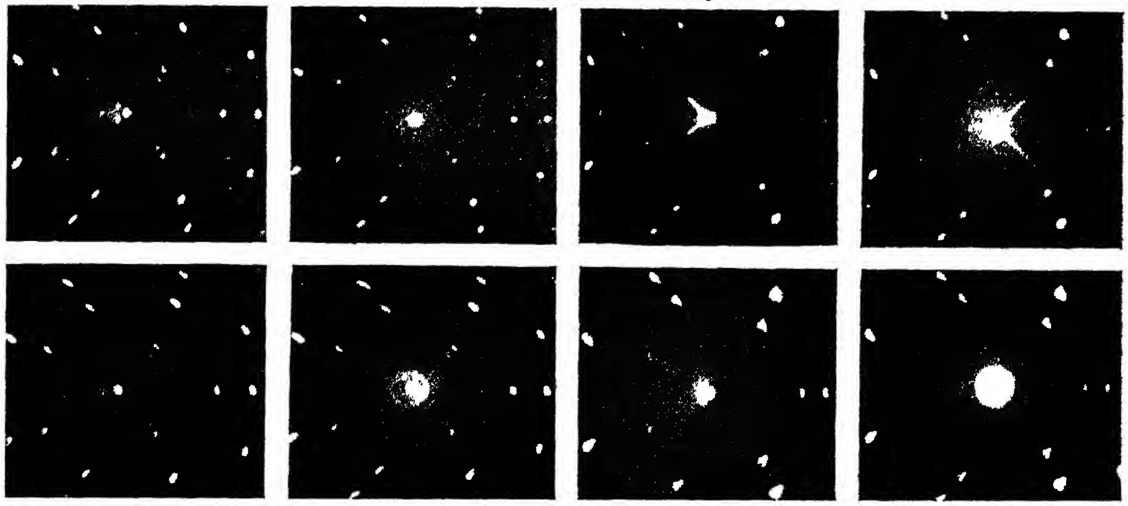
Observers of the diffuse scattering of X-rays by diamond[2, 3, 4, 5] have not hitherto stated which type of diamond they used. We have recently, through the kindness of Prof. W. T. Gordon, had the opportunity of examining some of the diamonds actually used by Robertson, Fox and Martin, as well as a number of other, smaller diamonds. Several of these diamonds, which were classified[1] as being of the rarer, "transparent" type II, gave results which were quite different from those obtained from type I diamonds. It would appear that the effects previously reported have always been those typical of the normal variety; these we propose to describe first.

The best photographs have been obtained with a small octahedral crystal, mass 1 mgm., using copper $K\alpha$- and β-, iron $K\alpha$- and β-radiations. Laue photographs have been taken at small intervals over a range of up to $\pm$ 20° from the Bragg angle on either side of the {111} {220} {113} [{331} and {004}] planes. The measurements on each series of photographs, when plotted on appropriate reciprocal nets, give in accurate detail the shape and extent of the diffracting regions around the reciprocal lattice points. From the data we find that these points are each surrounded by a small, roughly spherical region of diffuse ("primary") scattering, which only extends to about 3° from the Bragg angle, but that there are, in addition, regions of very sharp, intense ("secondary") diffraction along some or all of the reciprocal [100] [010] [001] axes. There are six such 'horns' extending in reciprocal space from the (111) points, more than half-way across the Brillouin zone in each case. The well-defined streaks, and triangles of sharp spots observed on photographs of diamond in various orientations correspond with great accuracy to the sections of these 'horns' by the sphere of reflexion. It is, however, an extraordinary fact, not as yet explained by any theory, that the {220} and {113} points in reciprocal space are not accompanied by six horns, but only by four. For the (220) and (113) points the [001] horns are missing, for the (202) and (131) points the [010] horns are missing, and the [100] for the (022) and (311) points. These results have been confirmed on crystals definitely classed by Robertson, Fox and Martin as being of type I, including diamond D 23, which showed unusually high photo-electric conductivity for that class.

Diamonds of type II show what we have called "primary" diffuse scattering, but the "secondary" effect is entirely missing. There are no sharp streaks, no triangles of sharp spots around a diffuse centre; only the diffuse centre appears, this being somewhat more persistent than in type I. Thus in the reciprocal net corresponding to type II diamonds, the horns of strong diffraction along the cube directions do not exist, either for the (111) or for any other points, so far as could be ascertained. Otherwise, the Laue pictures of the two types of diamond are identical, allowance being made for the very different shapes and sizes of the crystals used.

In the photographs illustrating the ordinary

d c b a



h g f e

Top row: Diamond, Type I. Bottom row: Diamond, Type II.

diffraction from the (111) plane in various orientations, (*a*)—(*d*), and its modification in the transparent diamonds, (*e*)—(*h*), the photographic film has been placed either *normal to the reflected beam*, as in (*a*) (*e*) (*b*) (*f*), or at 10° to the incident beam, as in (*c*) (*g*) (*d*) (*h*). In (*a*) and (*e*) the crystal is set at θ_B and in (*c*) and (*g*) at $-\theta_B$, where θ_B is the Bragg angle of incidence for iron $K\alpha$ radiation and the (111) plane (28·05°). In these photographs, rings appear around the (111) reflexion, due to diffraction of the monochromatic reflected beam by the black paper covering the film-holder[6]. These rings, which are evidence both of the intensity of the reflected beam and of the accuracy of the crystal setting, disappear when the angle of incidence θ is more than $\pm 0{\cdot}3°$ from θ_B. Hence they are not present in photographs (*b*) and (*f*), where $\theta = \theta_B + 1$, or in (*d*) and (*h*), where $\theta = -(\theta_B + 2)$. The most remarkable difference between the two types of diamond illustrated by these photographs is that type I gives, in addition to the ordinary (111) reflexion, a diffuse spot accompanied by streaks or surrounded by a triangle of sharp spots, [in (*c*) the triangle is due to iron $K\beta$ radiation, the $K\alpha$ triangle being coincident with the Laue-Bragg reflexion], whereas in type II the (111) reflexion is accompanied only by a diffuse spot, without streaks or triangle. Another important difference is that type II diamonds are much better monochromators than ordinary diamonds (to judge from the intensity of the 'paper' rings), owing partly to the absence of extinction[1], and partly, no doubt, to the almost complete concentration of reflected radiation into a single nearly cylindrical beam.

It may be that what we have called the "primary" and "secondary" diffuse phenomena have different origins; that is a matter for further experiment. The investigation of the diffraction from different diamond planes was undertaken principally in order to find out whether the distribution of scattering power around the various reciprocal lattice points was the same, as the Preston–Bragg block theory would indicate, or different, as allowed by the Faxén–Waller heat theory[7]. Differences *have* been found, but they are not differences which are permissible according to the theory. Moreover, the compltee disappearance of the streaks and triangles in the diamonds of type II definitely eliminates the possibility of these "secondary" effects being due to thermally excited lattice vibrations. Any adequate explanation of the "secondary" spots and streaks (as distinct from the "primary") must account both for the differences between different planes in type I and the absence of the effect in type II.

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Increased Yield of Nucleic Acid-like Substances from Irradiated Yeast

EVIDENCE that yeast irradiated with full ultra-violet light produces nucleic acid-like proliferation-promoting factors[1] led us to compare the yield of nucleic acid from irradiated and non-irradiated yeast in the following experiments.

Starch-free yeast (*S. cerevisiæ*, Fleischmann bakers' strain) was suspended at 300 gm. per litre in distilled water or 1 per cent dextrose. The suspension was divided into two fractions, one of which was irradiated with full ultra-violet from a Hanovia quartz mercury arc until half or more of the cells were killed, while the other was kept at the same temperature without irradiation. Nucleic acid was then prepared from both portions by the method of Johnson and Harkins[2].

In all, three preparations were made. The yield of crude nucleic acid from irradiated yeast (4·5–8·5 gm. per 300 gm. of yeast) was, in each case, greater than that from non-irradiated yeast (3–4 gm. per 300 gm. of yeast). Ultra-violet absorption spectra showed the typical maximum at 2600 A. characteristic of nucleic acids and their derivatives[3]. The extinction coefficient

of the nucleic acid from irradiated yeast was slightly higher than that from non-irradiated yeast, despite the greater yield of the former.

The third preparation was tested for growth-stimulating activity on cultures of yeast grown in rocker tubes in Reader's medium according to the usual techniques[4]. Both the preparation from irradiated yeast and that from non-irradiated yeast showed growth-stimulating activity, contrary to our previous findings for purified nucleic acid[5]. The activity per unit weight of the preparation from irradiated yeast was about twice as great as that from non-irradiated yeast, from which one may deduce that the proliferation-promoting activity was not due to nucleic acid as such but to contaminants (possibly closely related chemically) in the crude preparations.

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Distribution of the Double Linkings in Irone

THE formulation of irene as 1 : 1 : 2 : 6-tetramethyltetralin[1] has recently been established synthetically by Bogert and Apfelbaum[2]. On the basis of this formulation of irene and the production of ββγ-trimethyl pimelic acid by ozonization of irone, structural formulæ have been postulated for this ketone by Ruzicka and his co-workers[3]. Two of the postulated structures contain the chromophoric system $C = C - C = C - C = O$ which should therefore give rise to a characteristic absorption spectrum.

We have recently prepared a specimen of irone from oil of orris and having ascertained that it had the appropriate constants and yielded the characteristic *p*-bromophenyl-hydrazone, we examined its absorption spectrum. This was found to exhibit an intense band at 2280 A. ($\log \varepsilon = 4{\cdot}08$) and an inflexion near 3080 A. ($\log \varepsilon = 2{\cdot}03$), the two together being characteristic of an αβ-unsaturated ketone. The location of the intense band indicates the presence of a monosubstituted αβ-unsaturated ketone[4] (probably $R.CH = CH - C(R) = O$) and clearly shows the $C = C - C = C - C = O$ structure to be absent. This inference is supported by the fact that the absorption spectrum of α-ionone (λ max. 2285 A.) is almost identical with that of irone (λ max. 2280 A.).

A full account of these results will be published elsewhere.

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Stafford Allen & Sons, Ltd., London, N.1. June 23. T. F. WEST.

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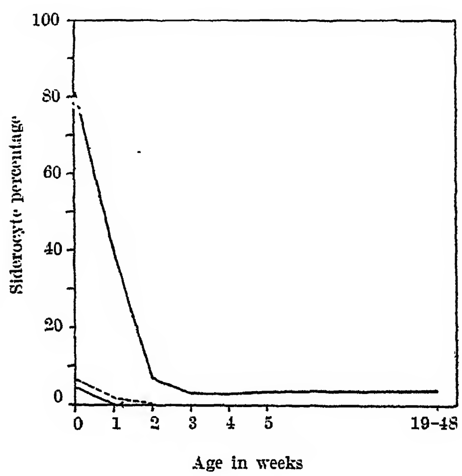
Siderocytes: a New Kind of Erythrocytes

IT is generally known that the presence of iron in the hæmoglobin molecule cannot be detected by the usual histochemical tests, such as the Prussian blue reaction with potassium ferrocyanide. As a consequence, tests for the presence of 'free' or easily detachable iron have scarcely been used in hæmatology.

I have recently investigated the anæmia associated with the recessive gene for flexed-tail and belly-spot in the mouse (*Mus musculus* L.)[1]. The anæmia is of a normocytic hypochromic type; it is severe at birth, but disappears more or less completely during the first few weeks of life; it can be shown that this improvement is inextricably linked up with the transition from the megaloblastic erythropoiesis of



PERCENTAGE OF SIDEROCYTES IN FLEXED-TAILED MICE (HEAVY LINE), NORMAL MICE (THIN LINE) AND NORMAL RATS (DOTTED LINE).

the fœtus to the normoblastic erythropoiesis of the adult, a process which in the mouse, as in the rat, largely takes place after birth.

It has recently been found that newborn flexed-tailed mice have numerous red cells which give the Prussian blue reaction for iron. (Blood films fixed in absolute methyl alcohol were treated with a freshly prepared solution of 1 per cent potassium ferrocyanide in 1 per cent hydrochloric acid at room temperature for 3–5 minutes and counterstained with Biebrich scarlet; the iron reaction is complete after one minute; identical results are obtained with hydrochloric acid concentrations down to 0·05 per cent; with 0·02 and 0·01 per cent hydrochloric acid, only a fraction of the cells will stain.) The 'iron cells' or 'siderocytes' do not stain diffusely, but show blue granules which vary in number from one to a dozen or more and in size from fairly large blobs down to the finest dust-like stipples; no such structures are visible in cells stained with Biebrich scarlet alone or with one of the ordinary hæmatological stains. As shown in the accompanying graph, the percentage of siderocytes diminishes rapidly with age; their reduction in numbers takes place at about the same rate at which the anæmia improves.

It was afterwards discovered that the presence of siderocytes is a normal feature in the embryonic life of the mouse; about 4 per cent are still present

at birth, while by the end of the first week siderocytes have nearly disappeared from the circulation. I am not certain whether in normal mice siderocytes are altogether absent later in life; it is difficult to be sure whether a very occasional dark stipple is or is not an artefact; if siderocytes are still present later in life, their frequency does not exceed 1 : 1,000 red cells. Siderocytes have also been found in new-born normal rats (*Rattus norvegicus*); their decline in number seems to be somewhat slower than in the mouse. Work is under way to discover whether the presence of siderocytes is a feature confined to the embryonic life of rodents.

The iron-containing compound in siderocytes is apparently distinct from the hæmosiderin pigment found in various pathological conditions, which s a brown granular substance visible in unstained preparations; in the majority of cases it is a breakdown product of red cells and has never been found inside intact erythrocytes in the circulation. The most likely suggestion is that normal mouse and rat embryos, and in a grossly exaggerated form flexed-tailed mice, partly furnish their red cells with a hitherto unidentified precursor of hæmoglobin, from which the iron can easily be split off. A less likely interpretation is that the easily detachable iron in siderocytes is the result of an unknown type of hæmoglobin breakdown taking place within the erythrocytes. The relation of the iron-containing compound in siderocytes to the 'labile iron' in blood studied by Legge and Lemberg[2] is uncertain.

A detailed account of this work will be published elsewhere.

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Breeding of Xenopus in the Laboratory

Xenopus lævis is specially favourable for certain types of bio-assay. It is suitable for assay of gonadodesmic[1] extracts[2]. The clawed toad is the only satisfactory test animal for assay of melanophore-stimulating substance, that is, *B* substance [3, 4, 5]. The Hogben test for pregnancy is undoubtedly by far the most economical of those put forward so far, and its reliability is well established [6, 7, 8, 9]. The toad is easily kept in good condition and is an ideal laboratory animal. At the present time the drawback to its use is the difficulty of importing it from the natural habitat. Fortunately, however, Xenopus in good condition[7] ovulates at any time in response to injection of gonadodesmic extracts. So it is possible to produce progeny in large numbers and as required. We adopted the following procedure with successful results.

An injected male and an injected female were placed in a flat-bottomed dish. Coupling occurred within twenty-four hours with the production of fertilized eggs[10]. These were then transferred to a tray kept just under the surface of the water of an aerated aquarium. The temperature of the aquarium was about 22°, and its minute flora and fauna were typical of a well-stocked freshwater pond in Great Britain. Water from a number of other well-stocked aquaria trickled through the aquarium bringing in plankton and keeping the water free from breakdown products. When the eggs hatched young larvæ were transferred from tray to aquarium. Under these conditions tadpoles continued their development through metamorphosis to young adults. The latter were then fed daily with finely chopped fresh liver or muscle. They grew fast—12 months after oviposition the average weight was 9–10 gm. and the body length 4–5 cm. At this stage the toads are easily handled, and can be used for assay of *B*-substance and gonadodesmic extracts. They can replace the frog for many experimental purposes. The tadpoles, which can be obtained at any time of the year, could be used for assay of thyroid and thyrodesmic extracts.

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Plankton as a Source of Food

WHILST it is correct to say that on occasions concentrations of algæ in eutrophic lakes and reservoirs will be very high, it should be remembered that these peaks of production are of short duration. Again, of the dry weight of the diatom *Fragilaria crotonensis*, estimated at 110 tons, quoted by Walker[1], approximately one half is silicon. Further, the fine mesh of any netting that would be necessary to retain algæ would add enormously to the difficulties of collection. I am, therefore, doubtful whether attempts to use phytoplankton as food would be practical or economic, and, in my view, it would be better to investigate the possibilities of large-scale collection of marine zooplankton, as advocated by Hardy[2].

A rich zooplankton is found seasonally in fresh water, but although I have eaten Crustacea tow-netted both from Lough Derg, Ireland, and Windermere and found them not unpleasant, I feel sure that the collection of these smaller forms would present greater difficulties than that of the bigger marine planktonic Crustacea.

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RESEARCH ITEMS

Control of Gonorrhœa

In an address before the American Medical Association on June 6, W. Bromme claimed that complete control of gonorrhœa is promised by a new treatment. Complete cures in three days of one hundred out of one hundred men were achieved by sulphathiazole treatment. Large doses of the drug, averaging sixty grains a day, were continued in the same dosage for forty-eight hours after the patient is apparently cured. The patients in Dr. Bromme's series were crane operators, foundrymen and others employed in heavy industries. None of them lost a single day from work while taking the treatment. The sulphathiazole is given by mouth. Mild nausea in twenty-three patients and fever of 100·6° F., not enough for most persons to know they had fever, in six patients, were the only reactions to the drug. The author believes that large doses of the sulpha drugs at the start of treatment should be used not only for gonorrhœa but also for meningitis, pneumonia and streptococcus infections. He considers that fewer reactions and more effective cures will result from such doses than from the customary small, often-repeated doses. The small, often-repeated doses of these drugs, which many medical men have used on a cautious basis, provide a chance for the patient to become sensitized to the drug, with resulting untoward symptoms requiring stopping of the drug, and also give the germs a chance to become used to the drug, so that it does not affect them. This is probably the basis of the 'sulphanilamide resistance', which has been reported as a cause of failure of the sulpha drugs in some cases in which patients did not get well even after long treatment.

Artificial Synthesis of Wheat ($n = 42$)

By combining two dissimilar relatives of wheat, E. J. Britten and W. P. Thompson, of the University of Saskatchewan, have obtained a 'synthetic' hybrid plant closely resembling the common cultivated species (*Triticum vulgare*) (*Science*, May 16). Ordinary cultivated wheat has forty-two chromosomes. It is commonly believed that it originated as a natural hybrid between two other species with lower chromosome numbers. To test this theory, Dr. Britten and Prof. Thompson hybridized a fourteen-chromosome species of wheat (emmer, *Triticum vulgare*) with a wheat-like grass (*Ægilops speltoides*) with only seven chromosomes. This hybrid plant had twenty-one chromosomes, but was completely sterile. The authors then treated the hybrid intensively with a solution of colchicine, making daily injections with a hypodermic needle. This eventually resulted in the formation of heads of grain that had the chromosome number of cultivated wheat (forty-two) and were fully fertile. In external characters, also, the artificially produced plants showed considerable resemblance to ordinary wheat.

Dominance in Gossypium

S. C. Harland and O. M. Atteck (*J. Gen.*, **42**, 21–47; 1941) report the results of a series of backcrossing experiments involving the crinkled mutant of cotton. They believe that dominance has been obtained to crinkled in *Gossypium hirsutum*, *G. purpurascens* and *G. Taitense* by the method suggested by Fisher. In these species, modifiers have been selected in the heterozygote towards modification of the dominance relations and amelioration of the crinkled character. In *G. barbadense*, *G. tomentosum*, and *G. Darwinii*, there is a normal allelomorph of great dominance potency as postulated by Haldane's theory. The recessive condition in these species is relatively unmodified. A discussion of the Fisher effect is given.

Leaf Colours of Coleus

C. L. Bonge (*J. Gen.*, **42**, 191–196; 1941) has published the results of his experiments to elucidate the various colours of commercial Coleus. There is a multiple allelomorph series *Pp–gp*. *P* determines purple colour, which is dominant to p_g which gives green leaves; while the recessive *p* gives a central pattern of colour to the leaf. At another locus, *I* gives a blue-green colour and its allelomorph *i* gives a yellow-green colour to the leaf. Interaction of expressions between these non-allelomorphic genes is observed in certain combinations; for example, *Pp-gI* gives a 'grey' leaf colour, whereas *PpI* gives rise to purple leaves.

Biology of Indian Rust Fungi

Life-histories of two rust fungi attacking the forest tree *Pinus longifolia* have been elucidated by the work of K. Bagchee (*Indian For. Rec.*, Bot., **1**, No. 7, 247; January 1941). *Peridermium himalayense*, on the stem of the tree, is related with a new species of Cronartium upon a species of Swertia as host, as shown by cross inoculation with teleutospores. The other fungus, *P. orientale*, attacks the pine needles, and is the alternative stage of *Coleosporium campanulæ* on *Campanula colorata*. It is interesting that another physiological form of this fungus on *Campanula canescens* cannot induce the æcidia to appear on the pine host.

Solubility Effect in Benzene

Krauss and Fuoss since 1933 have shown from conductivity, freezing point and dielectric constant measurements that in cases where acid-base reactions are not involved, the properties of electrolytic solutions depend primarily on the dielectric constant of the solvent, and these properties have been interpreted on the basis of coulomb forces between ions, ion pairs and triple ions. A. W. Vernon, W. F. Luder and M. Giella (*J. Amer. Chem. Soc.*, **63**, 862; 1941) have measured the effect of tetramethylammonium picrate and nitrate on the solubility of tetrabutylammonium iodide in benzene, a solvent of low dielectric constant. Although a common ion is involved, the solubility of the iodide increases rapidly as the picrate or nitrate is added. In the case of the picrate, the solubility of the iodide increases linearly with the picrate concentration. The results indicate that there can be very few single ions present and that the salts are associated in the solvent of low dielectric constant ($D=2·28$). In the case of ethylene dichloride ($D=10·23$) the solubility effect is normal. In benzene there may be association to triple ions, quadripoles and even higher multiples. The conductance measurements show a minimum at

small concentration, the conductance slowly rising as the concentration is increased. The effects are too complex for quantitative treatment at present, but they are in qualitative agreement with the theory. Thus, the solubility of the iodide at first increases more rapidly on addition of nitrate than with the picrate, and the theory indicates a higher association when symmetrical ions are involved.

The Acetyl Radical

THE presence of the acetyl radical, CH_3CO, as an intermediate in the photolysis of some carbonyl compounds, and its instability at higher temperatures have been observed. Not only may it decompose into a methyl radical, CH_3, and carbon monoxide, but it may also disappear by some other reactions which do not liberate carbon monoxide. The carbon monoxide yields in the photolysis of compounds which can form an acetyl radical might be expected to show similarities in their variation with temperature. H. W. Anderson and G. K. Rollefson (*J. Amer. Chem. Soc.*, **63**, 816; 1941) have tested this point by measuring the dependence of the carbon monoxide yield on temperature from 0° to 140° in the cases of the photolysis of acetone, diacetyl and acetyl bromide vapour. The conclusion is reached that acetyl radicals are formed with such high energies that some of them decompose spontaneously into methyl and carbon monoxide. If this initial surplus of energy is lost by collisions, the acetyl radicals may either decompose or combine to form diacetyl, the decomposition reaction becoming increasingly important above 50°.

Hydrolysis of Methyl Acetate

ONE of the classical examples of a first-order reaction is the hydrolysis of methyl acetate in presence of a large excess of water, in which the reverse reaction is also neglected: $CH_3.COO.CH_3 + H_2O = CH_3.COOH + CH_3OH$. By working in acetone as a solvent instead of water, where the water concentration changes materially during the reaction, and using sulphuric acid as catalyst, H. B. Friedman and G. V. Elmore (*J. Amer. Chem. Soc.*, **63**, 864; 1941) find that the reaction is really of the second order, the velocity being proportional to the ester and water concentrations. It was also found that the velocity coefficient for the second-order reaction was more constant when the reverse reaction (esterification) was taken into account, so that the velocity equation is: $dx/dt = k(a-x)(b-x) - k'x^2$, where a and b are the initial ester and water concentrations and x is the concentration of acetic acid produced by hydrolysis. The value of the equilibrium constant, $K = k/k'$, was found from the equilibrium concentrations in presence of excess of water. Then if $K' = 1/K$, the velocity equation is $(1/k)\ dx/dt = (a-x)(b-x) - K'x^2$, from which the values of K were found from the integrated form of the equation.

Activity of Thallous Chloride

THE solubilities of thallous chloride in presence of potassium chloride in solvents composed of ethyl alcohol and water in varying ratio have been measured by E. Hogge and A. B. Garrett (*J. Amer. Chem. Soc.*, **63**, 1089; 1941), and the results considered from the point of view of the activity of the thallous chloride. If $m_\pm$ is the mean molality, $\sqrt{m_+ m_-}$ and I the ionic strength of the solution, the graph of $\log m_\pm$ against $\sqrt{I}$ should be a straight line; or, if this is not the case, the limiting slope should (for infinite dilution or $I=0$) have a theoretical value given by the Debye-Hückel theory of strong electrolytes. This theoretical value of the limiting slope was not found in any case. The first-order correction for mean distance of ionic approach also gave (as is often found in other systems) impossible negative values. Since thallous chloride is a moderately weak electrolyte, however, a correction for ionic association must be made; and it was found that when this was applied the results were satisfactory. The effect of the dielectric constant of the solvent was in qualitative agreement only with the theory of Born, and the deviations increase as the dielectric constant decreases.

Stress and Strain Relation for the Atomic Lattice of Iron

S. L. Smith and W. A. Wood (*Proc. Roy. Soc.*, **178**, 93) have measured the lattice spacing of iron by X-ray methods while applying tension to the specimen, and have thus obtained a stress–strain relation for the atomic lattice. The spacing was measured at right angles to the stress and the changes are therefore compared with the lateral contraction observed externally. Up to the yield point the contraction is proportional to the stress; beyond this point the contraction slows down and eventually reverses into an expansion. It was further found that a permanent expansion may be produced by stressing beyond the yield point. It is concluded that the observed effect of stressing beyond the yield point was due to the superposition of an elastic contraction, comparable with that observed externally, and a lattice deformation leading to expansion. Further experiments showed that the permanent expansion after loading took place along the direction of stress as well as at right angles to it, and hence results in a decrease of density. Recovery of the lattice was produced by gentle heat treatment at temperatures well below those necessary for recrystallization.

Nova Cygni III (1920)

THIS extraordinary star increased its brightness, probably in little more than a fortnight, by a factor of more than 250,000, the greatest rise ever recorded for an ordinary galactic nova. A recent monograph by R. B. Baldwin (*Publ. Obs. Univ. Mich.*, **8**, 61; 1941) gives a critical discussion of its spectrum through maximum light and for the six weeks thereafter during which spectroscopic observation was practicable at Ann Arbor. The general development of the star followed that observed in other novæ: great quantities of material were ejected in shells from the central star. In this case no less than eleven shells were detected, their velocities of ejection varying from 400 km./sec. for the first to nearly 3,000 km./sec. for the last. An unusual feature shown by almost all the various spectra is the extreme diffuseness of their absorption lines and emission bands, suggesting a wide range of atomic velocities in the individual shells. Another abnormal development noted by Baldwin is that a year after the outburst (by which time the star showed a visible disk) the velocity shown was not the expected 750 km./sec. of absorption II, the principal feature which had dominated the spectrum since three days after maximum, but 1,200 km./sec., corresponding to absorption V, a relatively transitory feature of the spectrum.

BIOLOGY OF EPIDEMICS*

By Prof. W. W. C. Topley, F.R.S.

THE universe of study which to-day faces the epidemiologist is not, in its essence, composed of a number of cases of a clinically recognizable disease, with a distribution that varies in an observable way in space and time. It is composed of a variety of biological species, some acting as parasites and some as hosts. The parasites may be viruses, or bacteria, or protozoa, or worms. The hosts may be men, or animals, or insects, or plants. The parasite may pass from host to host by direct contact, by indirect mechanical contact, or through the agency of an insect vector. In whatever way it passes, the main factor that determines the occurrence and type of an epidemic prevalence is the frequency of its passage.

If all relevant environmental conditions are held constant, and susceptible hosts are added at a high and steady rate to an infected herd, a steady rate of mortality is attained, with no major waves or fluctuations. If, with a steady rate of addition, the closeness of contact between host and host is changed, increased closeness of contact is followed by the propagation of a major epidemic wave, and decreased opportunity for contact by a rapid fall in the mortality rate. These experimental observations have many analogies in the recorded prevalence of infectious disease under natural conditions.

During an epidemic prevalence the average resistance of the hosts rises with length of exposure to risk; in part because of the elimination by death of the more susceptible individuals, in part because of the natural immunization of survivors. The resistance attained in this way, though sometimes high, is never absolute. We can, in many cases, attain the advantages of natural immunization, without its risks, by an appropriate method of vaccination.

Differences in severity between different epidemics of the same disease are in part accounted for by biological differences between various strains of a single parasitic species, between different races of a single species of host, or between different races of a single species of insect vector. The biological characters that determine the ability of a parasite to spread from host to host are not identical with the characters that determine its ability to multiply rapidly in the host's viruses, so that virulence and infectivity may vary independently.

In attempting to control epidemics we always strive, in one way of another, to decrease the probability of the passage of the causative parasite from an infected to a susceptible host. We may do this by changes in the distribution of the hosts at risk, or by lessening the population density of an essential insect vector, or by reducing the proportion of susceptible hosts by artificial immunization, or in many other ways. In no case is it necessary, by our own action, to reduce the probability to zero. The epidemic system is in unstable equilibrium. If we tip the balance far enough in favour of the host, the system itself will do the rest, and the disease will tend to become very infrequent, and may sometimes disappear.

* Substance of the Croonian Lecture delivered before the Royal Society on July 17.

LUMINESCENT MATERIALS*

FOR some years before the War there had been increasing interest in the fundamental and applied aspects of the luminescence of solids concurrently with a search for new and better luminescent solids by commercial firms. The possibilities in war of such materials are considerable; whilst it is obviously impossible now to discuss applications in the Services, there are many which can be made of value to the public at large. Unfortunately, at the outset of war, commercial development outran technical knowledge in the materials presented for sale to the public, and the consequent crop of failures aroused public prejudice against them.

The subject has been under investigation by a specially formed expert committee of the Civil Defence Research Committee, which has now issued a bulletin largely to explain how luminescent devices can best be used in present circumstances. The work of the Committee has covered both a comprehensive study of the theory of the subject including, in particular, the laws of phosphorescence; an attempt to make good the deficiencies in luminescent materials and improve their method of manufacture; and an indication of possible applications. The bulletin in particular names the materials available and their properties, sources of irradiation, and enumerates a large number of possible applications, though the list is by no means exhaustive or complete.

The theory of the subject has been studied particularly by Dr. J. T. Randall at the University of Birmingham in recent years, where a method has been developed of studying the electronic 'traps' in luminescent solids. Such solids owe their properties to the presence of minute traces of an impurity, and their preparation depends on the addition of an activator to the pure matrix materials followed by a heat treatment which causes an intimate association of impurity atoms and matrix lattice.

The commoner luminous pigments fall into two main classes: (i) zinc and zinc cadmium sulphides; (ii) alkaline earth sulphides. The former have a high fluorescent brightness but relatively short periods of afterglow; the latter exhibit lower initial brightness but have longer periods of afterglow. To make these materials really useful in practice there must be uniformity in behaviour from batch to batch and, in the long run, their properties must be improved. In

* Luminescent Materials and their War-time Uses. Bulletin C.17, Ministry of Home Security, Research and Experiments Department, Princes Risborough, Bucks.

simple language, the number of 'traps' has to be increased and a means of control of the rate of their discharge found. It is to this end that an understanding of the theory of phosphorescence is required; success will mean that better powders are possible. The stimulus to manufacturers given by the existence of the Committee is said already to have resulted in a marked improvement of the commercial products.

But it is not enough to make the active products; they have to be incorporated into paints, plastics or enamels, and shielded in a manner which gives protection against weathering if they are to be exposed out of doors. In addition, the greatest care has to be taken during the incorporation lest the activity of the phosphors be lessened.

The problem has still another side when fluorescent materials are used, since these have to be continuously energized by ultra-violet radiation. The types of source of this which are available are indicated in the bulletin. A minor point here is the relatively short useful life of the argon lamp: probably research is already going on in other quarters to improve this. It is suggested that, could this be realized and the lamp 'mass-produced', a great stimulus would be given to the use of fluorescent materials rendered visible by such means.

It is clear that the scope of what at first sight might appear to be a limited investigation is in reality quite wide and that the existence of the Committee is fully justified. It is to be hoped that the results of its work will be made available at least in quarters where this can be applied for the public weal. This is the more desirable since it is known that luminescent materials were widely applied in France and Germany last winter, whereas little use was made of them in Great Britain: this in spite of the fact that there was no lack of knowledge of them in scientific circles in England.

THE ROYAL OBSERVATORY, GREENWICH

Annual Report of the Astronomer Royal

The annual report of the Astronomer Royal, just published, refers to the work of the Royal Observatory during the period May 1, 1940–April 30, 1941. To those who know the position of the Observatory, in the midst of military and industrial objectives, it will come as no surprise that much of the work has been curtailed by enemy action. The last report mentioned the dismantling of much of the optical apparatus; most of the mirrors and lenses have now been sent away from Greenwich for safety. Since heavy bombing of London started last September, night observations have been impossible on such of the telescopes as had not already been dismounted at the outbreak of hostilities; in fact, the only observing programmes still carried on at Greenwich are daylight ones, namely, the routine meteorological work and the photographic and visual solar observations.

The public time service functions well from two emergency outstations, as the familiar 'six pips' regularly testify. The Rugby rhythmic signals, however, in present circumstances fall short of the high precision needed for control of frequency standards, though they are, of course, quite adequate for navigation. Rating of chronometers and watches and their issue to the Royal Navy continue as usual, though the entire establishment concerned has been moved for the second time in two years.

Work has ceased on the Airy transit circle after continuous observation with this instrument for ninety years. More than 650,000 observations have been made with it, forming the most important contribution from a single instrument to fundamental positional astronomy. The new reversible transit circle which is to take its place has obtained nearly 10,000 transits during the last three years. When observing ceased in September 1940, the work of determining the division errors had been completed and an investigation started on the irregularities of the pivots. These latter have already been found to be extremely small.

The photoheliograph and spectrohelioscope observations show the expected decline in solar activity from the 1937–38 maximum, the sunspot frequency having dropped to about half that at maximum. Nevertheless, twenty-one large groups of spots occurred, six of them being later associated with magnetic storms. One of these latter, that of March 1, 1941, ranks high among the most severe disturbances of the past ninety years. The associated spot could not be extensively observed because of cloud, but the number of short-wave radio fade-outs occurring during its central meridian passage suggests that it was chromospherically very active. Over the year as a whole, however, both chromospheric eruptions and radio fade-outs were few.

The meteorological department of the Observatory has celebrated its centenary of routine observations. Features of the year's weather include an August drier than any for 122 years, and a period from December to April during which each month was considerably colder than normal, the temperature in the Stevenson screen never reaching 59° F. for the whole five months.

Discussion of the photographic material, comprising nearly 3,000 plates, obtained during the 1931 opposition of Eros, is now practically complete. The solar parallax deduced from these observations at stations all over the world is $8{\cdot}790'' \pm 0{\cdot}001''$, the previously accepted value being $8{\cdot}80''$.

The "Nautical Almanac" office continues its essential work, though it has had to contend with the destruction by fire of the whole of the type and plates for all its publications except the "Astronomical Navigation Tables". The consequent delay in publication is being rapidly made good, in some cases by using photographic reproduction in lieu of printing from type.

Astronomers all over the world will join in sympathizing with the Astronomer Royal and his staff on the interruption of many of their long-established programmes, and in congratulating them on their maintenance of essential services throughout a very trying period.

FORTHCOMING EVENTS

SATURDAY, JULY 26

BRITISH PSYCHOLOGICAL SOCIETY (at Tavistock House, Tavistock Square, London, W.C.1), at 10.30 a.m.—Discussion on "Psychological Problems of Air Raid Shelters and Evacuation".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 30).

ASSISTANT LECTURERS (TWO) IN SCIENCE, MATHEMATICS AND DRAWING in the Halesowen County Technical School—The Clerk to the Halesowen Local Higher Education Committee, 21 Great Cornbow, Halesowen, Worcestershire (July 30).

PHYSICIST FOR THE BRADFORD REGIONAL RADIUM CENTRE—The House Governor and Secretary, Bradford Royal Infirmary, Bradford.

REPORTS AND OTHER PUBLICATIONS

Great Britain and Ireland

Children's Nutrition Council (Edinburgh Branch). Food and the War: a Report on an Enquiry into the Adequacy of the Incomes and Expenditures of One Hundred and Three Families on Low and Moderate Incomes, during the Period April to November 1940. Pp. 28. (Edinburgh: Children's Nutrition Council.) 3*d*. [17

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 803, Vol. 239: The Theory of the Division in Saturn's Rings. By G. R. Goldsbrough. Pp. 183–210. 5*s*. 6*d*. Series B: Biological Sciences. No. 576, Vol. 231: Foraminifera from the Green Ammonite Beds, Lower Lias, of Dorset. By Dr. W. A. Macfadyen. Pp. 73+4 plates. 15*s*. (London: Cambridge University Press.) [17

Lister Institute of Preventive Medicine. Report of the Governing Body, 1941. Pp. 26. (London: Lister Institute.) [17

Annual Reports on the Progress of Chemistry for 1940. Vol. 37. Pp. 525. (London: Chemical Society.) 15*s*. [17

Jealott's Hill Research Station. Bulletin No. 3: Home Production and Use of Feeding-Stuffs in War. By W. R. Peel and S. J. Watson. Pp. 36. (Bracknell: Imperial Chemical Industries, Ltd.) [77

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. War Food Production. Advisory Bulletin No. 4: The Best Utilization of Hill Land. By Moses Griffith. Pp. 20. (Aberystwyth: Welsh Plant Breeding Station.) 1*s*. [77

British Electrical and Allied Industries Research Association. Technical Report, Reference L/T 100: Dielectric Properties of Experimental Resin-Paper Boards. By Dr. L. Hartshorn and E. Rushton, with N. J. L. Megson. Pp. 14. 2*s*. 6*d*. Technical Report, Reference L/T 121: Dielectric Loss in Dipolar Solids, 1: Solutions of Dipolar Molecules in Solid Paraffins. By H. Fröhlich. Pp. 12. 11*s*. 6*d*. (London: British Electrical and Allied Industries Research Association.) [87

Emergency Medical Services Instructions. Part 1: Medical Treatment and Special Centres. Pp. 60. (London: Ministry of Health.) [107

The National Trust for Places of Historic Interest or Natural Beauty. Report 1940–1941. Pp. 104. (London: The National Trust.) [107

My Work and Ideas (1908–1941): a Brief Account of Notions or Points of View on which Pioneer or Explanatory Work has been done in England and the West Indies, with some Account of the Results and of the Circumstances that led from one Notion to Another. By W. R. Dunlop. Pp. 15. (London: The Author, 57 Gordon Square.) [147

Other Countries

Forest Research in India, 1939–40. Part 2: Reports for Burma and Indian Provinces. Pp. iii+218. (Delhi: Manager of Publications.) 3.12 rupees: 6*s*. [17

Uganda Protectorate. Annual Report of the Forest Department for the Year ending 31st December 1940. Pp. 8. (Entebbe: Government Printer.) 1*s*. [17

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 106: A Report on Agricultural Features of the Australian Potato Industry. By Dr. J. G. Bald. Pp. 72. (Melbourne: Government Printer.) [17

University of California Publications in Zoology. Vol. 42, No. 7: Structural Adaptations in Thrashers (Mimidæ: Genus Toxostroma) with Comments on Interspecific Relationships. By William L. Engels. Pp. iii+341–400. 75 cents. Vol. 42, No. 9: Geographic Variation in Bushy-tailed Wood Rats. By Emmet T. Hooper. Pp. ii+407–424. 25 cents. Vol. 44, No. 1: A Biogeographical Study of the Ordinoides artenkreis of Garter Snakes (Genus Thamnophis). By Henry S. Fitch. Pp. iii+150+7 plates. 1.50 dollars. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) [77

Occasional Papers of the California Academy of Sciences. No. 19: The Rabbits of California. By Robert T. Orr. Pp. iii+228. (San Francisco: California Academy of Sciences.) 3.50 dollars. [77

Proceedings of the American Academy of Arts and Sciences. Vol. 73, No. 8: Amphibians and Reptiles in Nevada. By Jean M. Linsdale. Pp. 197–258. (Boston, Mass.: American Academy of Arts and Sciences.) 1.85 dollars. [77

Proceedings of the United States National Museum. Vol. 90, No. 3106: New Fishes of the Family Callionymidæ, mostly Philippine, obtained by the United States Bureau of Fisheries Steamer *Albatross*. By Henry W. Fowler. Pp. 32. (Washington, D.C.: Government Printing Office.) [77

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 138: The Economic Biology of some Australian Clupeoid Fish. By M. Blackburn. (Division of Fisheries: Report No. 6.) Pp. 152. (Melbourne: Government Printer.) [77

Ontario Research Foundation. Report for the Year 1940. Pp. 33. (Toronto: Ontario Research Foundation.) [77

Imperial College of Tropical Agriculture. Report of the Governing Body and the Principal's Report to December 31st, 1940, and the Accounts for the Year ended August 31, 1940. Pp. 32. (Trinidad: Imperial College of Tropical Agriculture.) [77

Cornell University: Agricultural Experiment Station. Bulletin 743: Instalment Credit in the Sale of Washing Machines. By Mabel A. Rollins. (Contribution from the Laboratories in Home Economics.) Pp. 36. Bulletin 747: Some Facts concerning Costs of Operation of Farm Motor Trucks. By M. P. Rasmussen and P. S. Williamson. Pp. 30. Bulletin 751: Costs of Farm Power and Equipment. By J. P. Hertel and Paul Williamson. Pp. 38. Memoir 232: A Catalogue of the Plecoptera of the World. By Peter Walter Claassen. Pp. 235. Memoir 233: Germination of the Conidia of *Sclerotinia fructiola*, with Special Reference to the Toxicity of Copper. By Ch'wan-Kwang Lin. Pp. 34. (Ithaca, N.Y.: Cornell University.) [87

U.S. Office of Education: Federal Security Agency. Leaflet No. 57: Know Your Community as a Basis for Understanding the School's Problems. By Bess Goodykoontz. (Know Your School Series.) Pp. iii+35. (Washington, D.C.: Government Printing Office.) 10 cents. [87

United States Department of Agriculture. Technical Bulletin No. 769: Peat Resources in Alaska. By A. P. Dachnowski-Stokes. Pp. 84. (Washington, D.C.: Government Printing Office.) 15 cents. [87

Carnegie Institution of Washington: Department of Terrestrial Magnetism. List of Publications for the Year 1940. Pp. 14. (Washington, D.C.: Carnegie Institution.) [87

University of Illinois: Engineering Experiment Station. Bulletin Series No. 326: An Analytical and Experimental Study of the Hydraulic Ram. By Prof. Wallace M. Lansford and Warren G. Dugan. Pp. 70. 70 cents. Bulletin Series No. 327: Fatigue Tests of Welded Joints in Structural Steel Plates. By Wilbur M. Wilson, Walter H. Bruckner, John V. Coombe and Richard A. Wilde. Pp. 86. 1 dollar. Bulletin Series No. 328: A Study of the Place Factors in the Fractional Distillation of the Ethyl Alcohol-Water System. By Prof. Donald B. Keyes and Leonard Byman. Pp. 64. 70 cents. Reprint Series No. 21: Seventh Progress Report of the Investigation of Fissures in Railroad Rails. By Herbert F. Moore. Pp. 79. 15 cents. (Urbana, Ill.: University of Illinois.) [117

Canada: Department of Mines and Resources: Mines and Geology Branch. Report of Mines and Geology Branch for the Fiscal Year ended March 31, 1940. Pp. 60. Geological Survey Memoir 228: Nelson Map-Area, East Half, British Columbia. By H. M. A. Rice. (No. 2460.) Pp. v+86. 25 cents. Geological Survey Paper 41-1: Preliminary Report, MacKay Lake Area, Northwest Territories. By J. F. Henderson. Pp. iii+6+1 map. 10 cents. Geological Survey Paper 41-2: Preliminary Map, Great Slave Lake to Great Bear Lake, Northwest Territories. 10 cents. Geological Survey Paper 41-3: Preliminary Report, Ingray Lake Map-Area, Northwest Territories. By C. S. Lord. Pp. iii+12+1 map. 10 cents. Geological Survey Paper 41-4: Preliminary Map, Brazeau, Alberta. By B. R. MacKay. 10 cents. (Ottawa: King's Printer.) [147

Catalogues

Photography Applied to Plan Copying in Engineering and other Industries. Pp. 12. (Ilford: Ilford, Ltd.)

Special Products for Nutritional Research. Pp. 12. (Chagrin Falls, Ohio: S. M. A. Corporation.)

Annotated Catalogue of Works on Exact and Applied Science. (Sotheran's Price Current of Literature, No. 868.) Pp. 120. (London: Henry Sotheran, Ltd.)

The Significance of Vitamin K in Prothrombin Deficiency. Pp. 4. Modern Vaccine Treatment in Skin Injections. Pp. 4. (Greenford: Glaxo Laboratories, Ltd.)

Catalogue of Books on Botany, Entomology, Ornithology and General Natural History. (No. 284.) Pp. 28. (Oxford: Dulau's Department of B. H. Blackwell, Ltd.)

Colour Plate Books: Rare, Curious, Beautiful. (Catalogue No. 656.) Pp. 26. (London: Francis Edwards, Ltd.)

Old Science and Medicine, including many Association Copies. (Catalogue 62.) Pp. 42. (London: E. P. Goldschmidt and Co., Ltd.)

Cooke Optical Clinometer. (Publication No. 889.) Pp. 4. (York: Cooke, Troughton and Simms, Ltd.)

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NATURE

SATURDAY
AUG. 2, 1941

AN INTERNATIONAL INTELLIGENCE FRONT

FOLLOWING on the establishment last November by the Ministry of Labour of an International Labour Branch as a central agency for making the best possible use of the services and labour of Allied and other friendly foreigners in Great Britain, the industrial registration of friendly aliens which the Ministry commenced on June 9 is a belated step to enlist many valuable heads and hands in our war effort, with the success of which they are as much concerned as ourselves. The man-power position may indeed well make us anxious to secure the very important contribution to our war effort which should be possible from the quarter of a million of these refugees, many of whom could make expert contributions in particular fields.

While, however, the Government has now realized the damage to our national war effort which was done by the policy of internment, which although an urgent necessity at the time of the fall of France has long outlived the emergency, there are few signs that either the Government or the nation realizes the moral consequences or the psychological opportunities which were open to us in this field as soon as the migration from Germany under Nazi persecution commenced. These consequences and opportunities have been well portrayed by Sebastian Haffner in a penetrating survey of the German nation and its leaders and of the possibilities and objectives of Allied propaganda which appeared last year under the title "Germany : Jekyll and Hyde"*. This book is a damning indictment of the policy pursued in the democracies, including the United States, towards such refugees, even before the outbreak of war.

This arresting picture of the deplorable effect of the failure of the democracies to realize before the War the significance of this migration from Germany and, by adopting a generous policy, to establish an anti-Nazi stronghold beyond the reach of the Gestapo is not, however, solely one of opportunities irretrievably lost. It gains fresh interest as the growing stress of the conflict compels us to explore more thoroughly and exhaustively all our moral and material resources. We can no longer, it is true, confront the German Reich with not merely one hundred thousand but a couple of million from among its best, most intelligent and most educated citizens, with all the repercussions on German moral and material reserves which a migration on that scale involves. The Evian conference closed the door on that prospect, which the Nazis were astute enough to fear and to exploit when the danger passed.

* "Germany : Jekyll and Hyde." By Sebastian Haffner. Trans. by Wilfred David. Pp. 320. (London : Secker and Warburg, Ltd., 1940.) 8s. 6d. net.

For all the tragedy of Evian, however, Nazi propaganda is taxed to the utmost to conceal the fact that Germany entered the War as a thoroughly disunited nation and that large sections of her people fear victory more than defeat. This is still our great psychological opportunity. It can be seized only with the help of the *émigrés*, and that is the greatest contribution they can offer to our war effort.

It is still possible, however, to use this German anti-Nazi movement both in the fight against Nazism as well as in the subsequent necessary reconstruction of Germany. Far more significant than the formation from them of a German Freedom Legion would be, as Haffner suggests, the formation of a German Academy. The blow to Nazi prestige which such a step could deal is not to be underrated, and might be decisive in winning the War and in preparing the peace. Even more effective might be the utilization of the experience of internal German politics, the knowledge of German political psychology, and the underground ties with Germany which are represented by these *émigrés*.

Such an organization might well go farther. By supervising the refugees and their military, cultural and political organizations, it would serve as a link with the Allied Governments. It might elaborate plans for Germany's reconstruction and future constitution and establish semi-diplomatic relations with the opposition groups within Germany, through the neutral countries.

If these opportunities are to be seized and such possibilities realized, however, there must be a profound change in the attitude and policy of the Government and indeed of many of the ordinary citizens. The first step in a positive and constructive policy towards Germany is a constructive and positive policy to the German *émigré*. The great opportunity presented by the offer of co-operation of large numbers of German political intelligentsia, men of science and others, now living outside Germany, and of the many who, mortal foes of the Nazis, are numerous enough to form at least a symbolic kernel of a German army to fight by the side of the Allies, must be grasped. The refugees must not simply be treated with humanity; they must be harnessed to the common cause.

Important as is this political contribution, there is also the question of learning and scholarship represented by these *émigrés*, among whom is a high proportion of outstanding workers in science, medicine and literature. To this question and its implications Dr. Raymond B. Fosdick, president of the Rockefeller Foundation, once again makes striking reference in his review of the Foundation's work in 1940. Many of the brilliant men with whose work the Foundation was associated are now driven from the posts for which they were trained, debarred from their laboratories, some of them fugitives, some in concentration camps, many of them separated from their families or lost in foreign countries where they sought haven.

The sombre picture of the breakdown in international solidarity, which in the realm of scholarship, at least, had become a vital factor in progress, contained in Dr. Fosdick's review affords a background against which this question of the refugee or *émigré* must be viewed if we are to keep a true perspective. The conception of knowledge as an international responsibility has vanished from Europe. The free flow of ideas across boundary lines between laboratories and universities has dried up.

The condition of university life and standards on the Continent, Dr. Fosdick asserts, is now little short of appalling. Due to flight, imprisonment or disappearance, the number of professors in institutions has been reduced by at least 50 per cent. Over all the Continental universities hangs the pall of uncertainty and fear. The contact with contemporary life has been abruptly broken. Even when fundamental research is being continued, publication has largely been abandoned or postponed. In the social sciences such research as is carried on is confined to innocuous projects which have no relevancy to the present scene. Even neutral countries are under pressure to permit a totalitarian interpretation in teaching such subjects as economics, political science and sociology.

In such surroundings, as Dr. Fosdick reminds us, scholarship withers; nothing short of heroic struggle can keep it alive. It is only free men who dare to think, and it is only through free thought that the soul of a people can be kept alive.

Considerations such as these give pertinence to the suggestion of an *émigré* academy thrown out by Haffner, particularly if this is not limited to one nationality. The Rockefeller Foundation itself is indeed nobly striving to salvage some proportion of the productive scholarship of the refugees from the conquered countries. Two of its programmes, a placement programme from 1933 to 1939, and an emergency rescue programme in 1940, have endeavoured to protect the careers of scholars unable to continue work in their native lands. During the seven years ending in 1939, 775,000 dollars were appropriated by the Foundation on the first of these, about 500,000 dollars being allocated to American institutions where 122 individual scholars found places, 99 of whom were established in permanent positions by the end of 1939.

In 1940 the second rescue programme was instituted with the assistance of the New School for Social Research and, in the task of permanent

placement, by the Emergency Committee in Aid of Displaced Foreign Scholars. During 1940, on behalf of the refugee scholars endangered by the invasion of Scandinavia, the Low Countries and France, the Rockefeller Foundation made fifty-six grants totalling 266,350 dollars. The fifty-six scholars assisted included nineteen Germans, eleven French, seven Poles, five Russians, five Austrians, three Norwegians, two Spaniards, one Belgian, one Czech, one Italian and one Swiss. Among them were physiologists, biochemists, mathematicians, neurologists, statisticians, economists, historians, philosophers and philologists. One was a Nobel prize-winner and nearly all had international reputations.

Hopelessly inadequate as efforts of this kind may seem through the restrictions imposed on the occupied territories of Europe, they are not without value. At least they reveal the mockery of science and learning which parades in the vaunted New Order of Hitler, and how truly it would sound the death knell of culture and intellectual life. By themselves they are quite inadequate.

To accord to all aliens in sympathy with the ideals for which Britain is fighting the full status of allies with freedom of employment, domicile and movement is only the first step. Utilization of the services of the engineers, chemists, doctors and nurses at present waiting employment would demonstrate the solidarity of an international front against Nazism. The relief it would bring to our war effort is indeed the least of the consequences of such a step—every layman knows well how overburdened are medical men in general practice in almost every part of Great Britain.

What is above all required is a policy towards the *émigrés* which will enlist as fellow-workers and partners all in sympathy with the ideas and ideals for which we are striving and afford them full opportunity of making their own contribution to that end. That policy must be inspired by a large vision of the psychological possibilities, of the opportunities of a psychological war on Germany which could be carried on with such assistance, thus not merely shortening the war but assisting also to build a stable and better European order after hostilities have ceased.

To see in the presence of these foreigners, bitterly opposed to the Nazi regime and eager to fight with us to secure its overthrow, not dangers and hindrances to our war effort, real as some of the difficulties which attend an enlightened policy may be, to realize the counterpart to the Allied Governments already present in Great Britain which they represent, demands both courage and imagination. Without these and without magnanimity, such a war as this of ideas and of irreconcilable conceptions, of human values, of justice and of society cannot be won nor an enduring peace achieved. Given, however, the statesmanship alive to the human and moral issues involved, resolute to explore all the possibilities which the position of so many Allied Governments and political leaders from enemy or occupied countries offers us, and no less keen in its scrutiny of the dangers of treachery or abuse of privilege, decisive action greatly accelerating victory might well be taken. Bold and imaginative steps like the organization of some suitable institution where the great gifts and international reputations of many of these scholars could find ample employ might well set the stream of thought flowing across international frontiers once more, and shatter the pretensions of Hitler and the Nazis to stand even for a united Germany, let alone a wretched regime of slavery and tyranny imposed on one broken country after another. It would, moreover, add to our own effort all the inspiration which comes from a policy conceived in a spirit worthy of the great cause which we are pledged so deeply to defend and the ideals to which the free nations do homage.

THE CHURCHES CHALLENGED

A Challenge to the Churches

Religion and Democracy. By John Macmurray. (The Democratic Order, No. 9.) Pp. 63. (London: Kegan Paul and Co., Ltd., 1941.) 1*s*. net.

THE Churches have had so many "challenges" presented to them that they are becoming accustomed to take them as read, and this indifference is often justified by the ignorance of the challengers, but it is to be hoped that Prof. Macmurray's little book will have serious attention, for it is the cry from the heart of one who knows what Christianity has been and passionately believes in its creative power. In this pamphlet the author is conducting an argument on two fronts; he is pleading with his left-wing associates to realize that without Christianity there cannot be a socialist order which is also free, and he is trying to convince his fellow-Christians that the Church needs a new and drastic reformation.

The first of these theses rests upon an interesting and, as I think, convincing analysis of the tendency

of social evolution. The coming of large-scale State socialism is probably inevitable and, with it, the control by the State of the finances which in times past have been largely within the power of individual citizens. The religious sphere is the only one which can maintain itself independent of State control. The very possibility of democracy depends on the existence of a vigorous and almost universally accepted religion. If this condition be absent the State may profess the most extreme democratic aspirations but will be, in effect, a dictatorship. It appears to be Prof. Macmurray's opinion that this is what has happened in Russia. In an epigram which has perhaps prophetic truth he sums up his view by remarking: "Religion seeks to draw men into unity by love. Government seeks to compel them into co-operation by fear."

Bergson in his last great book, "Les Deux Sources", draws a distinction between static and creative religion, and though Prof. Macmurray does not refer to him, the fundamental idea on which the second of the theses rests is very much that of the French philosopher. The essential challenge to the Churches is that they have become the spiritual support of the old order, whereas if they had been true to the original gospel they would have been creating the new order. There is much salutary truth in the reproach, and I have no quarrel with the main contention; but it seems to me that some of Prof. Macmurray's statements in working out the idea are open to question. He suggests that Christian doctrine is the product of Greek philosophy to a much greater degree than history would warrant. It is strange that an eminent philosopher should object to the attempt to find a philosophical basis and formulation for a spiritual message. Most of all, it might be objected that he allows too little weight to the "other-worldly" elements in the New Testament. Christianity would be false to its deepest convictions if it came to hold that "in this life only we have hope in Christ Jesus". This is a small book which contains more matter for reflexion than most large ones; may it be widely read—and not only by members of the challenged Churches!

W. R. MATTHEWS.

ABORIGINAL TRIBES OF TRAVANCORE

The Travancore Tribes and Castes
Vol. 3: The Aborigines of Travancore. By L. A. Krishna Iyer. Pp. xxiii+176+54 plates. (Trivandrum: Government Press, 1941.)

THE late Dewan Bahadur L. K. Ananthakrishna Iyer will long be remembered as one of the pioneers of Indian ethnography, and his son, Mr. L. A. Krishna Iyer, of the Travancore Forests Department and at present in charge of the Ethnographic Survey of that State, is commendably following in his father's footsteps. His third volume of "The Travancore Tribes and Castes" has just been published. The first volume gave individual accounts of seven of the Travancore hill tribes, the second volume dealt with another eight tribes, and the present volume deals with all the fifteen comparatively and generally instead of severally.

Inevitably, no doubt, much of the previous information given is reiterated, and there are perhaps unnecessary duplications of tables and charts showing stature, cephalic index, etc., while the illustrations are in many cases repeated from one or other of the previous volumes. Ten pages are taken up with extracts from reviews in the Press and complimentary letters from individuals with regard to the contents of the first two volumes. There is, however, new material as well in the volume under review, apart from the comparative treatment. Thus there are a couple of pages on the blood-groups of Travancore tribes, in so far as figures are available. The results are interesting as suggesting three different strains among the South Indian aborigines, one in which group O constitutes about 50 per cent and A about 30 per cent, such as the Kadar, suggesting comparison with the Bushmen and Australians, another in which O is comparatively low, 20 per cent, while A stands at 60 per cent, the Paniyan, and a third, the Kanikkar, in whom the O group stands at about 50 per cent again, while A is less than 20 per cent and B is nearly 30 per cent. This is not a high percentage for B as figures for India in general run, but it is in marked contrast to both of the former groups.

A short chapter is also given to megalithic monuments, of which there are some good photographs. The author apparently inclines to Perry's view that megalithic monuments are everywhere to be associated with the search for gold on the part of "the archaic civilization". He quotes Newbigin to the effect that the uniformity of structure of megalithic monuments in India and Europe is accompanied by a corresponding uniformity of the skeletons contained therein, as all are dolichocephalic. The words used, however, do not seem to be actually Miss Newbigin's (her name,

too, is misspelled) and go farther than her actual text seems to warrant.

A chapter on racial affinities compares the views of various authorities. As elsewhere, the author modestly refrains from committing himself to any particular view, being content to sum up what others have stated. Other chapters deal with traditions, domestic life, exogamy, marriage, taboo, inheritance, etc., disposal of the dead, religion, and occupation and the clash of culture. The data set out have in many cases been given in the previous volumes when dealing with the tribes individually, but are here treated as a whole. The author occasionally leaves us in doubt as to his real meaning. Thus when he says that "the nephew of the Pulaya inherits the mortar and pestle and the youngest wife of his uncle" and takes his aunt to wife, presumably he means that the man marries his mother's brother's widow, as the system of the Garo tribe of Assam is adduced in comparison ; but it is nowhere made clear that he does not marry his father's brother's youngest widow, and we learn from vol. 1 that a Malapulaya may marry the daughter of his mother's brother or of his father's sister. A detailed note on the question would be worth publishing.

The issue of this volume completes the three volumes on the Travancore tribes, but the castes proper have not been touched in them, and it is much to be desired that the author should now proceed and deal with the castes. Most of the castes to be found in Travancore have been dealt with individually by Thurston and Rangachari in "The Castes and Tribes of Southern India", or by Mr. Iyer's own father in his "Cochin Tribes and Castes", so that a general approach on the lines of the present volume would be the most useful. Indeed a treatment of castes in this manner has possibly not yet been tried. Here is an admirable opportunity, and it is to be hoped that the Travancore State will not fail to make use of Mr. Iyer to complete a valuable series.

MOSQUITOES OF AFRICA

Mosquitoes of the Ethiopian Region
3 : Culicine Adults and Pupæ. By Dr. F. W. Edwards. Pp. viii+499+4 plates. (London : British Museum (Natural History), 1941.)

THE present is the third and final volume of a general monograph of the mosquitoes of tropical and subtropical Africa. The first volume (1936) by Hopkins dealt with the larvæ of the Culicine mosquitoes and covered both their biology and external anatomy. The second volume (1938) by the late Dr. Alwen Evans, gave a very detailed account of the Anopheline mosquitoes from all points of view. The present volume includes the adult and pupal characters of the African Culicines, together with the late author's judgment about the affinities of this difficult group. It may readily be understood that it has not been easy to secure coherence between the first and third volumes, which divide the account of the Culicines, and have come out at a five-year interval : none the less they are not seriously discrepant.

The greater part of the present book is descriptive and systematic : it deals with some 290 species of Culicine mosquitoes. The descriptions have been freshly drawn up for the present book, which also contains keys and lists of localities. It is illustrated by many hundred line drawings.

It is sometimes thought that a systematic work must be so specialized as to appear dull to the ordinary reader, but there are a number of points of very general interest in the volume before us. Owing to the need to recognize early stages in the field (in order to control mosquito breeding in the particular spots where harmful species breed) much attention has been given to the larvæ of these insects : indeed one might say that there are few groups of insects in which the early stages of so large a proportion have been collected, figured and considered. We have therefore what is still unusual, a systematic work which takes into account the early stages as well as the adult. The late Dr. Edwards had an encyclopædic knowledge of everything pertaining to these insects and could certainly use larval and pupal characters with as much mastery as he could those of the adult. It is therefore interesting to observe that, in his opinion, precedence should be given to the characters shown by adults, in those cases where there appears to be a conflict between the evidence derived from the adults and from the early stages.

The very close study to which African mosquitoes have been subjected has revealed information of general interest about the characters which sometimes separate species. There are, for example, several little groups in which there are sharp characters in the male genitalia, but no others, either in the external anatomy of the mosquitoes themselves or of their larvæ : but one is not entitled, from this, to conclude that specific differences will invariably be found in the genitalia,

for in other groups there are 'good species' with evident differences in pattern and colour but no points of distinction in the genitalia. There are also several instances of insects which are more readily distinguished in the immature stages than in the adult.

The book includes an excellent, well-illustrated introduction to the external anatomy of Culicine mosquitoes (adults and pupæ) with special reference to the characters used in systematics. This part of the book has considerable general value.

Dr. Edwards has given a large amount of space to discussing the zoogeography of his subject, and the provinces and subprovinces which may be based on these considerations. On the whole, he is able to accept the regions already proposed by Chapin for African birds.

The volume is a very scholarly addition to knowledge. In this, which was perhaps his last major work, the late Dr. Edwards has left something which will be of value not only in Africa but also in all other parts of the world. P. A. Buxton.

RECENT ADVANCES IN PHYSICS

Reports on Progress in Physics
Vol. 7 (1940). General Editor: J. H. Awbery. Pp. iii+362. (London: Physical Society, 1941.) 22*s*. 6*d*. net.

In spite of 'blitzes' and 'black-outs', of paper shortages and general war tension, vol. 7 of the Physical Society's "Reports on Progress in Physics" for the year 1940 has duly made its appearance, as well printed, well produced and not notably slimmer than usual. Physicists have come to rely on these annual volumes to keep themselves alive to developments in parts of their vast subject not peculiarly their own pet province, and the Society may be congratulated on the courage and foresight which have enabled it to continue the series through at least the first two years of the greatest war in history.

What hair-breadth escapes the volume may have suffered during production, and what may have been the editorial difficulties we are left to guess. The editor offers no apologies, for none are needed; and if he feels, as well he may, a quiet glow of satisfaction at a job well done under trying conditions, he allows no sign to escape him. Only here and there a modest footnote indicates that the times have not been quite normal. Future generations of readers—for these volumes are of more than ephemeral interest—will no doubt learn with surprise that "Dr. Eirich was engaged on this article when he was interned, and it has therefore been necessary to print it without bibliographical references". For the rest, the substitution of one author for another in one of the articles, and the inability of two others to follow up their very interesting article on the "Electrical Discharges in Gases" with a second part dealing with the practical applications of the subject are the only other *contretemps* recorded.

One of the anticipated joys of skimming through the latest volume of "Progress Reports" is the realization of how many branches of physics there are of which one knows next to nothing; and further, how many others, which one thought to have been worked out and safely interred in the pages of some standard text-book, have suddenly taken on a new lease of life. Dr. E. G. Richardson has collected more than ninety references to papers on sound published within the last two years (we wish he could have worked them into a rather more connected story) and Dr. Beattie and Dr. Stockmeyer, of the Massachusetts Institute of Technology, have found something fresh to say on the subject of "Equations of State". "Infra-red spectra," one knows, is a serial story which is likely to run through many volumes, but Dr. Harald Nielson's instalment in the present volume (again a contribution from the United States) is very welcome. One might have thought, however, that "Surface Tension" had been definitely cleared up. Dr. R. C. Brown in his article on the subject convinces us to the contrary.

What is generally known as "Modern Physics" is, of course, represented, though the editor, as usual, has wisely confined it within reasonable bounds. Dr. Feather writes on "The Gamma Radiations emitted in Nuclear Processes" and Dr. Peierls contributes an excellent article on "The Bohr Theory of Nuclear Reactions". Though it may seem a little invidious to distinguish a particular author when all are so good, one must say that Dr. Peierls's article is a model of the way in which such things should be done. With a minimum of mathematical symbols he succeeds in conveying to the average physicist, who has neither the time nor (to be quite frank) the mathematical ability to follow the original papers, a clear picture of the physical principles involved in the argument, and in convincing him of their plausibility.

Astronomy is represented by articles on solar physics, by Dr. Thackeray, and on the absorption of light in interstellar space, by Dr. Hunter. Dr.

Roberts gives an interesting account of interactions of gases with metals and crystals. Technical physics provides material for articles on photo-electric photometry, electron microscopes and new lenses ; and, in different vein, Dr. Allan Ferguson provides a charming little postscript on the development of the teaching of experimental physics in British universities.

It is an interesting and well-chosen menu which the editor has provided for his readers this year, and, on the whole, it is admirably served up. The authors have kept in mind the fact that, however much we may deplore it, the average physicist professionally engaged in cultivating his own little section of the field is no longer an expert in other parts of the subject, and looks to "Progress Reports" to keep him *au fait* with developments there. He will not be disappointed with the present volume. In the dark days through which we are passing, though money is being lavished on research on a scale unthinkable in the days when physicists were merely engaged on the advancement of learning and the betterment of mankind, it is unlikely that the results of their work will be available for publication in the near future; though we may hope that something of permanent value in science will result from so much strenuous activity. World war must call a halt to progress in physics, as to so many other civilized activities. We trust, however, that the ingenious editor will still be able to find some progress to report, and that he will find ways and means of reporting it.

J. A. CROWTHER.

ZOOLOGICAL LITERATURE

The Zoological Record

Vol. 76 : Being Records of Zoological Literature relating chiefly to the Year 1939. Compiled for the Zoological Society of London by A. G. Brighton, M. Burton, A. B. Hastings, C. A. Hoare, W. Nicoll, A. E. Salisbury, J. K. S. St. Joseph, W. L. Sclater. M. A. Smith, C. J. Stubblefield, E. Trewavas, E. I. White, R. J. Whittick, and the Imperial Institute of Entomology. Edited by Malcolm A. Smith. Pp. 1420. (London : Zoological Society of London, 1940.) £3 ; also in 19 Sections, issued separately.

THE seventy-sixth volume of the "Zoological Record", dealing with the literature published in 1939, appears a good deal later than usual (although some of the sections were issued separately many months ago), which, in the circumstances, is less surprising than that it should appear at all. Its compilation under war conditions must have involved much additional labour and great determination on the part of the editor and his contributors, and they are to be warmly congratulated on the completion of their task.

The arrangements for the cataloguing and indexing of scientific literature are among the problems of reconstruction that will have to be considered when the scientific world can again turn its attention to such things. It may not be inopportune, therefore, to inquire how far the "Record" meets the needs of present-day zoologists, and whether any improvements can be suggested to meet the needs of the future, so far as these can now be foreseen.

The "Zoological Record" is, by a long way, the senior of the current bibliographies that serve the congeries of sciences grouped under the name 'zoology'. To have maintained a continuous existence for more than three-quarters of a century is sufficient evidence of usefulness. Nevertheless, it is matter of common knowledge that its financial position is far from secure. For many years the Zoological Society itself sustained the very heavy loss involved in the publication of each annual volume. Some fifteen years ago, in response to an appeal sent out by Sir Sidney Harmer, a number of scientific societies and institutions in Great Britain and the United States and a few generous individuals came to the help of the Society, and enabled the "Record" to be carried on. A financial statement prefixed to the present volume shows that this help continues. In the year 1939, £450 was contributed by the trustees of the British Museum, £250 by the Zoological Society, and smaller sums amounting to £172 came from other sources. These contributions, however, failed by £114 to bridge the gap between the cost of production and the amount received from subscriptions and sales. Clearly, an increased circulation must be aimed at if the "Record" is to have an assured future.

The "Zoological Record" was originally founded by systematists for systematists, and the arrangement of its subject-matter has always been predominantly systematic. It will be generally agreed that in this respect it has been, on the whole, remarkably successful. It is still the only publication to which the zoologist can turn with the

certainty of finding (within the limits of human fallibility) references to all new genera and species, and all important additions to the systematic knowledge of species already named and described. There can be very few serious workers in any branch of descriptive zoology, in any part of the world, who find it possible to carry on without at least occasional reference to its pages. There are, indeed, some minor blemishes and a few major ones apparent in the present volume that might be remedied without increasing its bulk, but there is no need to dwell on them here.

But if the "Systematic Index" sections of the "Record" do meet, more or less adequately, the needs of systematists, other zoologists are likely to find themselves bewildered if they look for guidance to the "Subject Index". In this index a uniform classification of the subject-matter in each of the divisions of the "Record" allotted to the major groups of the animal kingdom is obviously desirable. Yet in the present volume no such uniformity exists. Each recorder makes his own choice of categories under which the data are classified and the headings used for them. This haphazard arrangement of the Subject Index makes it of little use to zoologists engaged in branches of research other than systematics.

W. T. Calman.

THE SCIENCE OF CANNING

Canning Practice and Control
By Osman Jones and T. W. Jones. Second edition, revised and enlarged. Pp. xiv+311+107 plates. (London: Chapman and Hall, Ltd., 1941.) 32s. net.

That a second edition of this book has been found necessary in such a short time proves that it has fulfilled a definite purpose. There are not many authoritative books on canning—a section of the food industry which, although not new (for certain of Napoleon's armies were supplied with canned foods), has nevertheless only developed to its present huge proportions during the last forty years or so—and therefore a compilation by the two authors, both of whom have had considerable (practical and theoretical) experience, was received with pleasure by those interested in the application of science to the industry. There are many new features in the second edition, but one might have expected that certain aspects of the first edition would have been altered—as they could have been with profit to the book. The difficulty, as the reviewer sees it, was to do justice in some three hundred pages to the whole of the ground which the authors attempted to cover; a difficulty which has been experienced by many authors seeking to stress the scientific aspect of an industry whilst endeavouring to convey to the reader an appreciation of the 'practice' of the industry.

What, in effect, have the authors attempted to achieve? They have endeavoured to bring before their readers a practical treatise on canning and an authoritative text-book on the chemistry and bacteriology of canning, and, in the reviewer's opinion have only succeeded in drawing together from a scattered technical literature and from purely scientific papers, certainly reinforced by their own practical experience, a number of facts which are largely commonplace. If the experienced packer were faced by some out-of-the-ordinary problem, reference to this book would scarcely yield an answer. The whole trouble is that limitation of space results in a superficial treatment of the subject. The best practical chapter is that concerned with packing in glass, for the information on this aspect of 'canning' is notably meagre.

The same restriction has reduced the value of the scientific sections of the volume. The reader would naturally expect authoritative statements on tests to be carried out on the products being canned. The authors have chosen to detail, as an example, some thirty-five different methods of analysis in approximately twenty pages, with the obvious result that the instructions are sometimes incomplete, sometimes ambiguous and sometimes carelessly presented.

The bacteriological sections also suffer. The authors have considered it advisable to treat with some of the fundamentals of bacteriology, but they have also practical hints to give, methods of testing to describe, with the result that both theory and practice suffer. The chapter on the staining of micro-organisms is a good one and full of useful information.

Unfortunately the book reminds the reviewer of publications where the work of the authors has been marred by a too ambitious interpretation of their object.

This is the opinion of the reviewer, but he may be the only person in step in the battalion—a second edition has been found necessary.

L. H. Lampitt.

LOWLAND TROPICAL PODSOLS AND THEIR VEGETATION

By DR. P. W. RICHARDS,
BOTANY SCHOOL, CAMBRIDGE

PODSOLS are soils characteristic of cool temperate regions with a damp climate, and until recently they were generally thought to be absent in the zone between about 40° N. and 40° S. Some years ago, however, Senstius[1] showed that podsolization occurred at high altitudes in the mountains of Java and the Philippines, though he did not find any mature podsols. Hardon[2] afterwards described well-developed podsols at about 2,000 m. in the Arfak Mountains in New Guinea (latitude 1° 10′ S.). In these observations there was nothing surprising, because, except for the smaller seasonal range of temperature, the climate at high altitudes in the equatorial zone may be very like that of cool temperate lowlands. It is the object of this article to point out that podsols (or soils similar to podsols in most of their characteristics) occur in the tropical lowlands down to sea-level, a fact which is not generally recognized and which does not accord with the climatic theory of soil development—at least in the form in which it is often stated.

These podsols of the tropical lowlands are not found sporadically, but have a wide distribution in the tropical rain-forest region of both hemispheres. They occur side by side with tropical red earths, the prevailing soil type of the equatorial zone, and are developed under the same climate. Where the rainfall permits, the natural climax vegetation of both tropical red earths and of lowland tropical podsols is usually rain-forest; but the rain-forest of the podsols has marked characteristics of its own and may be regarded as an edaphic climax. Under certain conditions (not yet understood) the podsols of the rain-forest belt may bear locally a type of evergreen scrub which is apparently also a climax type of vegetation.

These facts have been established by a series of steps which have been more or less as follows. The existence of bleached sands ('white sand') in the Tropics has been known for a long time. The botanical traveller Richard Spruce[3] met with large areas of white sand in the Rio Negro region of the Amazon and noted that the rain-forest on this soil—called by the natives *caatinga* forest—was different in composition from the forest elsewhere. The 'bleached earths' of the tropics are mentioned by Ramann, who in his "Evolution and Classification of Soils"[4] refers to the fact, well known to travellers in the South American jungle, that streams rising in the bleached soils are coloured brown by highly dispersed humus ('blackwater'), while streams from the red earth soils are colourless ('whitewater').

Bleached sands are widely distributed in the Guiana peneplain. At Moraballi Creek in the Essequibo basin, for example, a deep, porous and completely bleached sand forms a capping to low ridges and plateaux. This sand bears a highly characteristic type of rain-forest, dominated by the leguminous tree, *Eperua falcata* Aubl. (Soft Wallaba). This 'wallaba forest' is strictly confined to the bleached sand, and where it adjoins other soils the vegetation changes abruptly. In some parts of British Guiana the bleached sand bears other peculiar types of rain-forest which replace 'wallaba forest'. In 1934 a few analytical data from a soil profile in the 'wallaba forest' were published[5]. The significance of the data was not fully appreciated at the time, but it was noted as remarkable that the samples, though acid (pH about 4·8), gave a negative result with Comber's test, showing that they were deficient in iron as well as in bases (as would indeed be expected from their appearance).

In the Malayan region, bleached sands, similar to those of South America, were seen by Beccari[6] and probably by other travellers, but they seem largely to have escaped the notice of soil scientists and botanists. In 1932 I met with bleached sands in several localities in Sarawak (Borneo)[7], for example near sea-level at Marudi on the Baram River and at an altitude of about 750 m. on Mount Dulit. These sands were very similar to the 'white sand' of British Guiana, except that the texture was somewhat coarser. The vegetation was a type of evergreen rain-forest without a single dominant species, but strikingly different from the typical mixed dipterocarp forest which is the climatic climax of the region. This type of forest had previously been described from South Borneo by Winkler[8], who had called it *Heidewald* or 'heath forest'. The 'heath forest' of Marudi and Mount Dulit strikingly resembled the Guiana 'wallaba forest', in structure and physiognomy, though there was of course no species common to the two. Very significantly the Sarawak 'heath forest' differed from the local type of mixed rain-forest in precisely those characteristics in which the Guiana

'wallaba forest' differed from the Guiana mixed forest. The common factor between the two must clearly be a similarity of soil as well as climate.

Several soil profiles were examined in the bleached sand of the Sarawak 'heath forest'. The analyses showed the same feature which characterized the 'wallaba forest' soils—all the samples gave a negative or feeble reaction with Comber's test, though all of them were acid. In a brief discussion of these data I pointed out that the 'heath forest' soil strongly resembled a European podsol; unfortunately the analyses were not carried far enough to establish this conclusively.

The fact that the bleached sands of the Malayan lowlands are actually podsols was finally demonstrated by Hardon[9] in a paper published in 1937. In this, soil profiles were described from the island of Bangka and from a locality in East Borneo: the vegetation in both places was *padang*, a type of heath-like scrub or poor woodland, which occurs in areas with a rain-forest climate, and which is ecologically and floristically related to 'heath forest'. Both types of vegetation are found on bleached sands, and transitions from one to the other have been recorded. Some of Hardon's data are given in the accompanying table.

PROFILES OF LOWLAND TROPICAL PODSOLS.
After Hardon (1937).

Locality	Horizon	Depth cm.	Description	Percentage of sand (0·05–2mm.)	Percentage of clay (0·0005–0·005 mm.)	Organic Matter (%)	Molecular ratio $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ (for clay fraction)	*p*H	CaO (%)
Padang Loewai, E. Borneo	A_0	0–20	Brownish-black half-decomposed organic material	—	—	—	—	2·8	—
	A_2	10–120	Loose white quartz sand	97·3	0·5	0·1	—	6·1	0·008
	B	120–170	Yellowish-brown quartz sand	93·9	2·8	1·2	—	5·4	0·002
Bangka	A_0	0–10	Half-decomposed black organic material mixed with coarse sand	—	—	—	3·62	2·7	—
	A_1	10–25	Loose greyish-black hulme quartz sand	95·6	1·6	—	7·17	3·9	0·022
	A_2	25–40	Loose greyish-white quartz sand	94·0	0·6	—	8·64	6·1	0·032
	B_1	40–70	Hard pan. Dark brown, very compact quartz sand	86·9	7·2	5·2	0·42	3·9	0·029
	B_2	70–100	Loose light brown quartz sand	92·1	4·6	—	0·31	4·6	0·035

Both Hardon's profiles have a surface layer of blackish humus followed by a typical bleached horizon. Below this is a coloured horizon, which in the Bangka profile takes the form of a hard pan: clearly this is a *B* horizon. The percentage of clay is less than 1 per cent in the bleached layer and even in the coloured layer it is less than 10 per cent. The silica/sesquioxide ratios are typical for podsols—high in the *A* horizon, low in the *B*—indicating that sesquioxides are being removed from the *A* and deposited in the *B* horizon, while silica remains behind. All horizons are extremely poor in bases, even compared with other tropical soils. A striking feature is the excessively high carbon/nitrogen ratio of the humus layer (in one sample as high as 57), indicating very incomplete humification. The humus of these soils would thus appear to be of a *mor* rather than of a *mull* character.

There can be little doubt that Hardon is right in considering these soils to be podsols. Though in the Sarawak profiles no *B* horizon was found, probably because the sample pits were not deep enough, it seems certain that they belong to the same soil type. Hackenberg's[10] account of the South Bornean 'heath forest' mentions a blackened, consolidated soil layer at a depth of 1·5 m., which is doubtless the *B* horizon. That the South American bleached sands are also to be regarded as podsols seems extremely probable, though a full series of analyses for a deep profile is still needed. A profile at Moraballi Creek showed pure white sand extending down to 6 ft.; possibly a *B* horizon would have been found at a still greater depth. Unpublished notes by Mr. T. A. W. Davis on a white sand profile at another locality in British Guiana indicate a yellow layer at 77 in., which is possibly the *B* horizon.

The occurrence in the tropical lowlands of what appear to be podsols raises some interesting pedological questions. Under a tropical rain-forest climate, owing to the excess of precipitation over evaporation, movement of the water in the soil is predominantly downwards. Owing to the constantly high temperature, which accelerates the activities of micro-organisms, humus usually does

not accumulate. Now at high temperatures in water containing little organic matter, silica is relatively soluble and the sesquioxides of iron and aluminium relatively insoluble; thus silica tends to be removed preferentially from the upper soil horizons and sesquioxides to remain behind. The chief soil-forming process in the tropical rain-forest region is thus normally laterization, resulting in the development of a tropical red earth. The opposite process to laterization is podsolization, which is the removal of sesquioxides from the upper horizons, leaving silica behind. This usually takes place at temperatures low enough to favour humus accumulation, because in water containing dissolved organic matter sesquioxides are more soluble than silica.

Now the *padang* and 'heath forest' soils of the Malay islands and the white sands of British Guiana occur in what is a typical rain-forest climate both in respect of temperature and of rainfall. Indeed these soils are found side by side with typical red earths bearing normal mixed rain-forest. Why should podsolization sometimes take place instead of laterization ? Hardon gives no complete answer, nor can one be offered here; but it is at least clear that the nature of the soil-forming process must be ultimately determined by the properties of the parent rock. The bleached sands of Borneo are derived from coarse-grained Miocene sandstones which are probably initially poor in bases and in materials which would readily weather to a clay fraction. The Guiana podsols probably arise directly from white sands ultimately derived from the breakdown of granite, but afterwards sorted and deposited in a shallow sea during the Tertiary. Here again the parent material was probably deficient in bases and clay-forming materials from the beginning. In these extremely base-deficient soils there seems to be a tendency for raw humus to accumulate, even under tropical conditions. This raw humus leads to the preferential removal of sesquioxides rather than silica. Thus the nature of the parent rock locally outweighs the effects of climate and deflects the course of soil development from the start. If this is so, it strikingly confirms the view that vegetation, animals, soil and climate are all parts of one very complex interacting system (the "ecosystem" of Tansley): to regard one component of this system as determined by any other single component has little meaning.

Though all the factors controlling their development are not yet clear, it may be accepted that podsols occur in the tropical lowlands. These *lowland tropical podsols*, as they may be called, to distinguish them from the podsols of tropical mountains and temperate regions, have a wide distribution in both hemispheres. As well as occurring in Asia and America, there are indications, though no definite evidence, that they are found in tropical Africa. They are derived from sands or sandstones poor in bases, and bear a vegetation markedly different from the mixed rain-forest of the tropical red earths, which is the climatic climax of the region. In Borneo, in habitats with unimpeded drainage, the natural vegetation of the podsols is either 'heath forest' (perhaps better termed 'primary lowland rain-forest of bleached sands') or *padang* (evergreen scrub). The factors determining the latter are not climatic; if not due to felling, burning or some other biotic factor—as seems to be the case—it must depend on some soil factor, possibly a high degree of podsolization. In swampy habitats on soils of the podsol type, wood-moors (*Waldmoore*) develop. These are extensive lens-shaped masses of peat bearing a peculiar forest vegetation. They are found in the low-lying coastal plains of Borneo and Sumatra, and as shown by Polak[11], are closely comparable with the raised bogs of temperate regions, though the peat is formed chiefly of wood, not of the remains of herbaceous plants. In ordinary tropical swamps there is little tendency to accumulate raw humus; the peat-formation in these wood-moors cannot be due only to water-logging and consequent poor aeration. Possibly the very low concentration of bases in the ground-water inhibits the activities of micro-organisms.

In South America there are analogues to 'heath forest', *padang* and wood-moors. The 'wallaba forest' of Guiana, and other types of white sand forest, are the counterparts of the Bornean 'heath forest'. A corresponding type to *padang* in South America is the so-called '*muri* bush' of British Guiana, a low evergreen scrub dominated by *Houmiri floribunda* Mart. This occurs on white sand, chiefly as islands in 'wallaba forest'. Finally there are the 'pegass swamps' of the Guiana coastal plain, which though little investigated, are certainly very similar to the Malayan wood-moors.

The main reason why tropical podsols have been neglected is no doubt their low agricultural value. Attempts at farming on the white sands of Guiana show that they are unsuited to any kind of permanent cultivation (see Milne[12]).

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TWO THOUSAND YEARS OF HOME LIFE IN NORTHERN SCOTLAND*

By Dr. A. O. Curle, C.V.O.

At the extreme southern end of the mainland of Shetland there towers up the massive headland of Sumburgh Ness. Sheltered behind the Ness, and flanked by a long promontory which springs from the mainland on the west, is the Sumburgh Voe, a peaceful stretch of water running inland for about a mile. From the west side of the Voe, a low grassy headland rises above the general level of the coastline, affording a site for the various buildings which, now in ruins, bear the name of Jarlshof.

Some forty years ago, a violent storm swept the sand from the front of the shore bank on the side of the Sumburgh Voe and exposed some buildings. Here, adjacent, more extensive excavation in recent years has brought to light a group of dwellings, dating from the pre-Bronze Age of Shetland down to the Viking period in the eleventh–twelfth century.

The first dwelling to be described belonged to a pre-metal period in Shetland, for not a trace of metal or of any metallurgical process was found within it. It was a house built of drystone with flat-sided boulders selected from the adjacent beach, the walls of which still stood to a height of 2–3 ft. On plan it was elliptical, with the entrance in the centre of one end, and consisted of a small central courtyard, measuring some 10 ft. in diameter, with, on one side, two small cells rounded at the back, and, on the other side, two less deeply formed recesses, with a long chamber placed transversely at the back and measuring some 10 ft. by 6 ft. 6 in. There was ample evidence that the house was arranged to accommodate the cows as well as the family. Beside one of the lateral chambers lay the quernstone, *in situ*, a long trough-like contrivance, open at one end, on which the inhabitants had ground their grain, with the rubbing-stone lying nearby. Against the inner side of the front wall of the house lay four small four-sided pots of steatite or soapstone, evidently drinking-vessels, three of them as fresh as on the day on which they had left the maker's hand, and the fourth, a bottomless specimen which, inverted, had been used for the support of one of the others. The house must have been hurriedly vacated, and the drifting sand had dropped its mantle over everything before any marauder had come to disturb the contents. Sherds of pot represented the food vessels and cooking-pots. At a height of about 2 ft. above floor-level there projected from the side wall, opposite to where the quern lay, a small vertebra of a whale, placed in such a way that the side of the canal down which passed the spinal column protruded from the wall-face, thus providing a loop to which a cow or a calf could have been tethered.

Numerous relics were found in the dwelling, including a number of rude stone tools, among them objects of slate fashioned with serrated or sharp cutting edges, probably used in the preparation of skins, and closely resembling relics found in Norway belonging to the Arctic culture, and referable to a post-Magdalenian period. As neither whorls for spinning nor combs to be used in weaving were found we may presume that clothing was entirely formed of hides, carefully prepared with the help of the many slate and bone objects found in the course of the excavation. The pottery was rudely fashioned by hand, and without ornamentation, and the cooking for which it was used was effected by sinking the pot in the peat fire up to the shoulder. From the encrustation on the inner face of the potsherds, the diet appeared to have consisted largely ot stews.

From the entrance to this house a stone-paved passage of secondary construction, led by a rude stair of two or three steps, to a corridor. At the end of this corridor, on the right, a doorway opened into a small chamber. Here was a vivid picture of the life that had been lived within. At the entrance lay a quern, and, set up against it, ready to hand, was the rubbing stone to be used upon it. There was no trace of grain near it, so, presumably, the quern had been used for working up the clay which was found nearby, as a film of that substance was found on the surface of more than one of these querns in the course of the excavations, indicating that the grinding of grain was not the only purpose for which they were used. On the opposite side of the doorway from that on which lay the quern, was a heap of clay, carefully levigated, and still in a perfectly plastic condition suitable for making pots. Behind the quern were the remains of the fire on which the pots were, no doubt, fired; while in the wall behind the quern was a small ambry.

A doorway on the other side of the passage gave access to another house.

* Substance of a lecture entitled "Glimpses of 2,000 Years of Home Life as revealed by Excavations in the North of Scotland" delivered at the Royal Institution on May 15.

The plan of the courtyard house is as ancient as the time of the Minoan culture of Crete[1], reckoned to have belonged to a period between the second and third millennium B.C., and, as there is an absence among the relics from Jarlshof associated with the houses of this type, which would connect its introduction with any folk immigration, it may well have been traditional there from the advent of the Neolithic inhabitants to the island.

To the right of the entrance, on coming into the house, was a cell somewhat smaller than the rest. The front had been purposely blocked by large stones laid across it, and the cell itself had been converted into a rubbish pit in which were found some remarkable relics. Among them were numerous fragments of clay moulds which had been used for casting bronze swords ; pieces of more than one mould for casting a bronze axe ; a piece of the matrix of a mould for a pin of the sunflower type ; and several other fragments of moulds for indeterminate objects.

Clay moulds of the Bronze Age are exceedingly rare in Great Britain, and, not many years previous to this, the first recognized fragment of a sword-mould had been found on Traprain Law, near Haddington. It had previously been doubted, moreover, whether bronze had ever reached Shetland, and the appearance of a bronze sword on the island, far less the existence of a factory of them, had never been dreamed of.

On a secondary hearth was found a number of grains of bear, a species of coarse barley, showing that the inhabitants had been cultivators of the soil, as the numerous bones of sheep and oxen in their middens and elsewhere showed that they had owned flocks and herds. The complete absence of fish bones, as well as of fish hooks and spears, seemed to indicate that they did not seek their living on the sea, though the masses of limpet shells in the middens, and, to a lesser extent on the floors of the dwellings, showed that shell-fish formed one of their main sources of food.

On the paving of the court there was visible the site of the fire on which the smith had smelted his bronze. But a more interesting discovery was to follow. On clearing the floor nearby there was found a small pit in the vicinity of the hearth, measuring across the surface some 16 in. by 9 in., and in depth 11 in., with the sides converging until they were 6 in. apart, obviously the casting-pit into which the moulds had been thrust preparatory to the reception of the molten bronze.

But, besides the technical interest in these moulds and the casting, there is an even greater interest in the evidence they afford of a fresh contact with the outer world which Shetland had acquired.

The advent of the sword-smith did not synchronize with any apparent change in the character of the inhabitants of the Jarlshof settlement. Their houses continued, during the occupation in which the moulds were found, to be of the primitive courtyard type, and their tools and implements were little, if at all, affected. True, they had acquired new and formidable weapons of war, presuming the axe to be also a weapon, for, except for use on driftwood, bronze tools could here only be of limited application, the islands being treeless. Accordingly, the moulds supply no evidence for the advent of a fresh influx of people but rather of the coming of a single sword-smith, perhaps with his family, from across the ocean, bringing with him the implements of his craft. The type of the leaf-shaped sword, the sunflower pin, and other products, show that, from whatever land he had sailed, he had been trained in the Britannico-Irish traditions[2]. As Orkney, owing to the general difference of its archæological culture, may be ruled out as the land of his origin, we must look even farther afield, to the Western Isles, or even to Ireland itself, for the source from which he ventured on the perilous seas, in what would seem to us a very inadequate vessel for so long a voyage.

Besides the moulds, relics very similar to those found in the house previously described were recovered here ; but also chisel-shaped objects of bone, having the socket at one end, a type which corresponds closely with one from Denmark dating from a very remote antiquity. The presence of the Danish *Maglemös* type of chisel and of the peculiar slate tools suggests that Shetland had, perhaps for centuries, remained practically unknown to the outside world, lost in the wastes of ocean, and still preserving cultural evidence of a remote contact with northern Europe.

Adjacent to this house, but not in direct communication with it, was another and larger dwelling, which had been constructed on the ruins of a still earlier building. It also was a courtyard house. Here, too, the sword-smith had left evidence of his work, for numerous fragments of clay moulds were scattered about. In all, it was reckoned that as many as thirty swords were represented by the numerous fragments found in the settlement.

Until a few years ago, although the Viking occupation of parts of the north of Scotland and of the northern and western isles had left an indelible record in the place-names as well as in the surnames and physical characteristics of the people, yet no trace of the remains of a Viking dwelling had ever been exposed, or such a discovery recorded. By good fortune, such a house, and an associated homestead, were found at Jarlshof, which led afterwards to the discovery of another at Freswick on the Caithness coast, some five miles south of John o' Groats.

The earliest Viking houses were oblong on plan, with rounded ends. The walls were about 1½ m. thick and the same in height, and on the top of them rested the edge of the roof of timber and turf, supported by a row of wooden posts along each side of the interior. The ordinary rooms were three in number: the dining- and living-room known as the *stofa*; the sleeping-room or *skali*; the kitchen or *eldhus*. The Shetland example was a typical long house measuring, in its original state, 95 ft. in length by 12 ft. at either end, and 18 ft. at the centre.

At Freshwick a bath house was discovered. It was a small chamber, forming a somewhat irregular square of about 5 ft., with an entrance by a step in one side. The floor was carefully paved, except for a small area, in one corner where the fireplace had been, and which was filled with burnt broken stones and peat ash. From the floor a well-fashioned drain led through the wall of the chamber, and, continuing beneath covers along the floor of the main building, eventually discharged by way of an offset into a sump.

This was a typical vapour-bath, such as had been used in Scandinavian countries since early times, and which may still be met with there in country districts.

[1] Childe, "Prehistoric Communities", p. 183.
[2] Childe, *ibid.*

OBITUARIES

Dr. R. Bracher

DR. ROSE BRACHER, who died after a short illness on July 15, was born in 1894, the elder daughter of Reuben Bracher, a well-known teacher in Salisbury. She was educated in Salisbury and at the University of Bristol, where she graduated with first-class honours in botany in 1917. A year later she took her M.Sc. and then spent two years as demonstrator in the London School of Medicine for Women. The award of the Rose-Sidgwick fellowship allowed her to spend a year at Wisconsin, after which she returned to London as lecturer at East London College. In 1924 she came to Bristol to undertake research work; in 1926 she became assistant lecturer in the Department of Botany and in 1929 lecturer. In 1940 she was appointed senior lecturer—a title reserved for those who have given distinguished service to the University. A month ago she was elected a member of the Senate.

Dr. Bracher's principal scientific work was a study of the ecology of the great tidal mud-banks of the Bristol Avon and especially of the species of Euglena, which is the most conspicuous feature of its vegetation. Euglena appears on the surface and sinks into the mud with a rhythm which is largely caused by variations in illumination, and Dr. Bracher succeeded in working out in detail the part played by light and other factors in this striking phenomenon. The results were published in three distinguished papers in the *Annals of Botany* (1919), the *Journal of Ecology* (1929) and the *Proceedings of the Linnean Society* (1937). During the last ten years she was constantly engaged, along with her students, in work on the ecology of the Bristol district; the results have appeared in a series of papers of the greatest use to students of the vegetation of Somerset. As another consequence of this work she published two books, "Field Studies in Ecology" and "Ecology in Town and Classroom", which have been of especial use to teachers, showing, as they do, how interesting work can be carried on even in very unfavourable conditions.

Dr. Bracher was an admirable teacher and her services were much in demand for extra-mural work. She had notable success in rousing to an interest in biology members of W.E.A. classes and of others of that kind. In the University she had an unrivalled knowledge of the students, their problems and difficulties, and for some years she had been warden of the Women Home Students' Society. The tragedy of her early death is felt by a wide circle of colleagues and friends.

M. SKENE.

Sir Francis Anderson

THE death is announced of Sir Francis Anderson, emeritus professor of philosophy in the University of Sydney.

Sir Francis, who was eighty-two years of age, must have been almost the last survivor of that remarkable succession of pupils of Edward Caird (professor of moral philosophy in the University of Glasgow during 1866–1894) who themselves attained eminence as professors of philosophy. After an outstanding undergraduate career, crowned in 1893 by the award of first-class honours and the Clark fellowship in mental philosophy, Anderson spent two years as Caird's assistant, two years as assistant minister of the Australian Church in Melbourne, and then started upon his long and fruitful career as a teacher of philosophy in the University of Sydney—first as lecturer, and later, from 1890 until 1922, as professor in the newly founded chair of logic and mental philosophy.

Among the distinctions which marked this period were the presidency of the Mental Science Section of the Australasian Society for the Advancement of Science in 1897, and the presidency of the Social Science Section in 1907. Retirement from academic duties brought no abatement in his philo-

sophic interests, and from 1923 until 1927 he acted as editor of the *Australasian Journal of Psychology and Philosophy*. In 1927 his Alma Mater recognized his notable services to learning by conferring upon him the degree of doctor of laws. In his later years the cause of the League of Nations claimed much of his time and energy, and he was, from 1931 until 1936, president of the League of Nations Union (New South Wales). In 1936 he was created a knight.

Sir Francis's contribution to the literature of his subject was chiefly in the form of papers; but although he produced no major philosophical work, his influence upon the development of philosophical studies in the land of his adoption was powerful and widespread. The sphere of his academic influence and interests, however, extended far beyond the narrowly philosophical. The social sciences in general found in him an enthusiastic and untiring champion. Indeed the successive establishment in the University of Sydney of chairs in education (1910), economics (1912) and psychology (1920) was in no small measure due to his energetic advocacy. C. A. CAMPBELL.

WE regret to announce the following deaths:

Dr. C. S. Fisher, acting director of the American School of Oriental Research in Jerusalem, on July 20, aged sixty-five.

Prof. O. L. Shinn, professor of applied chemistry in the University of Pennsylvania, on June 10, aged sixty-nine.

Dr. L. A. Strong, chief of the U.S. Bureau of Entomology and Plant Quarantine, on June 2, aged fifty-four.

NEWS AND VIEWS

Sir Prafulla Chandra Rây, C.I.E.

ON August 7 the distinguished Indian chemist, Sir P. C. Rây, will celebrate his eightieth birthday. As a young student, Sir Prafulla was fortunate in coming under the influence of the late Sir Alexander Pedler, then professor of chemistry at the Presidency College, Calcutta, and on his recommendation Sir Prafulla proceeded to work under the late Prof. Crum Brown at Edinburgh, where in due course he graduated with the degree of D.Sc. Returning to India he became professor of chemistry at the Presidency College, Calcutta, and he remained in this post until his retirement under the age limit in 1916. He was then appointed Palit professor of chemistry at the University College of Science, retiring owing to failing eyesight in 1937. Valuable as have been Sir Prafulla's personal investigations, mainly in the field of nitrite chemistry, his outstanding contribution has been the foundation of an Indian school of chemistry. A true 'guru', devoting much of his income to the support of poor students, he sent forth from his laboratories a constant stream of young chemists fired with a zeal for original research. These young chemists now occupy most of the chairs of chemistry in Indian universities.

Sir Prafulla's interests have not been confined solely to academic research; his historical sense is shown in his "History of Hindu Chemistry", and he was responsible also for the foundation of the Bengal Chemical and Pharmaceutical Works. Naturally, Sir Prafulla's important work for India has received general recognition. He was appointed C.I.E. in 1912 and was knighted in 1916. He is a fellow of the Royal Asiatic Society of Bengal and of other Indian academies, and an honorary graduate of the Universities of Durham and Calcutta. He was president of the Indian Science Congress in 1920 and the first president of the Indian Chemical Society (1924). We trust that he may long be spared to inspire Indian youth.

Great Britain and the U.S.S.R.

IN NATURE of July 19, p. 79, brief reference was made to a broadcast from Moscow by Prof. P. Kapitza, which was addressed particularly to scientific workers in Great Britain. Prof. Vladimir Vernadsky, a veteran mineralogist and member of the Academy of Sciences of the U.S.S.R., also broadcast a message. These friendly gestures brought a reply from Prof. A. V. Hill, one of the secretaries of the Royal Society, who broadcast greetings to Russian colleagues and a reply to Prof. Kapitza in the European News sent out by the B.B.C. at midnight on July 14. Since then the Royal Society has dispatched the following cable: "President and Council of Royal Society London send greetings of Royal Society to National Academy of Sciences of U.S.S.R. Moscow. Our countries stand firm as partners in struggle against wanton aggression and our united efforts will ensure that the future of science is not endangered by destruction of those freedoms in which has thrived the work of the great scientists of both our countries enshrined in records of past and achievements of present. In the struggle science has already made and will continue to make essential contributions to victory."

Other bodies and individuals have joined in expressing their satisfaction that the U.S.S.R. can now be numbered among the Allies fighting against Nazi domination. The committee of the Division for the Social and International Relations of Science of the British Association has sent to the Academy of Sciences at Moscow a cable welcoming the alliance of British and Russian science, and expressing the hope that they "may in the near future be united in application to the establishment of a new and happier ordering of the affairs of mankind". The Cambridge branch of the Society for Cultural Relations with the U.S.S.R. sent a cable signed by the vice-chancellor and other members of the University

of Cambridge to the Academy of Sciences, to which Eugene Chudakov, vice-president of the Academy, has replied; and a group of biochemists at Cambridge, headed by Sir Frederick Gowland Hopkins and Dr. Joseph Needham, have sent "greetings and assurances of utmost support" to Russian biochemists through Profs. Bach and Engelhardt, of the Academy of Sciences, and the latter has replied, expressing his conviction that "the cause of progressive humanity will triumph over Hitlerism". Prof. Kapitza and Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, have also exchanged cables of greeting affirming their belief in victory for freedom of scientific thought.

"Fantasia"

The new film, "Fantasia", shortly to be generally released, will appeal not only to lovers of music, but also, from several points of view, especially to men of science. The basic theme of the film is the interpretation by artists of several well-chosen musical works. The fact that artists were chosen to interpret the music is a new departure for the screen; but of equal interest are the evidences of new technique adopted. The stereoscopic effect produced at the beginning of each half of the programme gives an almost complete impression of reality—in fact, for a moment it seemsal most impossible not to believe that the Philadelphia Philharmonic Orchestra and its conductor, Stokowski, are on the stage of the cinema. The first presentation—one of Bach's toccatas and fugues, so difficult to interpret as anything other than pure music that even the composer could not find a name for it—is here interpreted in a series of colour and wave forms that should delight and intrigue the physicist. He, too, will be amused by the introduction to the audience of the sound track as a "screen personality". Coyly comes the sound track on the screen where he is induced to demonstrate how he reacts to the sounds of various wind and string instruments. Though his reactions are impressionist to a degree, they are obviously based on the actual scientific facts.

Tschaikovsky's "Casse-noisette" is interpreted in a beautifully coloured floral ballet of a type familiar to regular cinema-goers; but susceptible lovers of Beethoven might be irritated by the interpretation of his "Pastoral" symphony-life on Mount Olympus. It is said that Beethoven claimed to compose always according to a "picture" he had in mind. Several years ago, the Russian Ballet based his wonderful seventh symphony on a religious theme, and it still remained Beethoven. But in "Fantasia", Beethoven appears as someone quite different, and not to our liking. The unusual continuity of the whole piece, without the slightest break between movements, might have contributed to our irritation. But Beethoven was a musician; to disarm such criticism "Fantasia" can definitely claim to be an artistic appreciation and interpretation of music.

There was one exception—and this number was an exposition of the origin and evolution of life by a group of men of science, and accompanied by Stravinsky's music. At any rate, the item claimed to be the origin of life; actually it represented the origin of the earth and was followed up by the origin of life and its evolution up to the arrival, and comparatively sudden extinction, of the giant reptiles of the Mesozoic. It is obvious that Mr. Disney carefully consulted authoritative astronomers and biologists before embarking on this unique production. The film lost its cartoon qualities and became almost real—Amœba engulfing its prey, Hydra somersaulting, other aquatic life, Pterodactyls, the small-brained herbivorous Brontosaurus and the fierce, carnivorous Tyrannosaurus, all coming to life in their true perspective so far as science is able to visualize it. This number will probably appeal most of all to men of science; despite certain detailed faults, it hus much more than entertainment value, as indeed has the whole film.

The Profession of Chemistry

In his presidential address to the Society of Chemical Industry (*Chemistry and Industry*, July 12, 1941), Prof. J. C. Philip outlined the history of recent efforts made by chemists to bring order and co-operation into their ranks by the formation of some kind of federal union. These efforts began at the close of the War of 1914–18, at the instigation of the late Lord Moulton, and are still continuing. So far they have had little result, and their recapitulation would have little interest except to chemists and possibly to other professional men who desire to substitute co-operation for extreme individualism and *laisser-faire*. Sectionalism, as Prof. Philip says, has undoubtedly been a determining factor in the want of success, but another, not mentioned by him, has been inability to choose the right type of leader, a defect which seems to be common in many democratic organizations. A learned professor, however brilliant in his own special field, will fail unless he possesses the power of influencing other men's minds, and his failure may lead to the emergence of the self-appointed type of leader who has a gift for oratory, that harlot of the arts, *et prœterea nihil*.

At the present time, the movement towards union is in charge of a Chemical Council, which was set up in July 1935, under a deed of agreement between the Chemical Society, the Institute of Chemistry, and the Society of Chemical Industry. Each of these societies is represented by three delegates, and there are also three co-opted representatives of industry, nominated by the Association of British Chemical Manufacturers. The Council undertakes the general administration of the funds available for the educational and scientific publications of the constituent bodies. The library of the Chemical Society, which has long outgrown the narrow confines of its rooms in Burlington House, is to remain the property of that Society but to be administered by a joint committee of the various bodies contributing to its maintenance. The Council disposes of funds that for the present seem adequate, but these would have to be largely supplemented were the old idea of a Chemistry House to materialize. A year ago a supplementary agreement was signed

extending the validity of the original agreement until 1947. Progress in collaboration has recently been effected by instituting a scheme which facilitates joint membership of two or three of the societies under payment of a reduced total fee ; and by giving members a wide choice of publications up to a specified limiting value. The provisions of the deed aim primarily at 'roping in' as many as possible of the 14,000 (?) scientific chemists now practising their profession, with the view of promoting the progress and status of chemistry in its threefold aspect of science, profession and technical applications. Nothing appears to be said about the obligations of the profession to the community, but there is little doubt that these could be and would be far better met by a united profession than by what has been called "a disunited rabble".

Rockefeller Foundation's Gifts to the National Central Library

At a time when the Trustees of the National Central Library are faced with difficulties beyond the normal, as a result of the loss by enemy action of about half its books and the greater part of its London building, the emergency grant of £2,200 which has recently been made by the Rockefeller Foundation comes as a most welcome gift. Some of the books lost will be irreplaceable, but, fortunately, many of them can be bought as the demand for them arises. The timely aid of the Rockefeller Foundation will be appreciated by many thousands of persons who will benefit by the valuable additional service thus placed at their disposal. The grant is also another illustration of the practical sympathy of the United States with the difficulties which have to be dealt with by those responsible for the work of cultural institutions in the British Isles. By helping the National Central Library, the Rockefeller Foundation is indirectly helping all other libraries which make use of the national service. The Rockefeller Foundation is also continuing to provide money for the upkeep of the Bureau of American Bibliography at the National Central Library.

Physical Society: Annual General Meeting

The sixty-seventh annual general meeting of the Physical Society was held on July 25 in the lecture theatre of the Science Museum, with Prof. Allan Ferguson in the chair. The reports of the Council and of the treasurer were adopted and the following officers for 1941–42 elected. *President :* Dr. C. G. Darwin ; *Hon. Treasurer :* Dr. C. C. Paterson ; *Hon. Secretary (Business) :* Dr. W. Jevons *: Hon. Secretary (Papers) :* Mr. J. H. Awbery ; *Hon. Librarian :* Dr. L. C. Martin ; *New Members of Council :* Prof. E. N. da C. Andrade and Dr. H. Shaw. Prof. Ferguson will undertake the duty of acting-president until Dr. Darwin is able to take office. The Council has to record a very successful year's work in difficult circumstances. Despite exceptionally heavy losses by death, the membership of the Society is scarcely affected, standing at 1,070 members at the end of 1940, as compared with 1,084 members twelve months earlier.

For the science meetings of the Society, the Council has adopted a new policy which has been justified by its complete success, the majority of the meetings having been devoted to discussions and to lecture-surveys. Discussions have been held on colour, the liquid state, the electrical and general physical properties of plastics, and the teaching of the fundamentals of electric and magnetic theory. Lecture-surveys have been given on contact-angles (Prof. Allan Ferguson), anemometry (Prof. P. A. Sheppard), gravity meters (Dr. J. McG. Bruckshaw), the magnetic hysteresis cycle and its interpretation (Prof. L. F. Bates), and some mechanical properties of glass (Prof. W. E. S. Turner). An outstanding event was the formation, within the ambit of the Society, of a Group for the discussion of scientific and technical problems relating to colour. The Group has already held three very profitable meetings, and its success encourages the initiation of similarly constituted groups for the discussion of problems of special interest to experts on the subjects to which the groups are devoted.

A Clouded Yellow Butterfly Invasion

One of the most interesting entomological features of the summer of 1941 is the invasion of clouded yellow butterflies (*Colias croceus* or *Edusa*) from the Continent which, since the first week of July, have been seen in Lancashire and Cheshire and various other parts of the north of England. This immigration has nothing to do with the War ; it is one of the more spasmodic immigrations of insects which occur from time to time, the classic example being the 'great *Edusa* year' of 1877, when flights ranged from the Orkneys to Land's End and Ireland. Several were seen in 1933, 1926, 1913, 1872, 1864, 1862 and 1859 and odd specimens in the north in other years like 1930. The greenish-white variety *helice* Hubn. has also been seen, while the rarer pale clouded yellow (*C. Hyale*) was observed in 1860, 1872, 1891, 1900–1, and at least one specimen has been noted at Ness, west Cheshire, during the present immigration of clouded yellows. A few clouded yellows from south Europe reach the south of England almost every year, arriving during May or June ; third brood larvæ are sometimes found in autumn on trefoil, lucerne or clover, and attempts at hibernation have been noted, but there is no record of surviving the winter here. Excepting in 1892, the common and pale clouded yellows are seldom abundant immigrants together.

Mineral Composition of Crops

It is generally recognized that the mineral composition of crops has an important bearing on human and animal health, and increasing attention is being paid to the interrelationships between such fields of investigation as soils, fertilizers, plant composition and the nutritive value of food. Although it is true that several nutritional diseases can be directly traced to the deficiency or excess of particular minerals, as yet the data are usually quite insufficient for the laying down of direct recommendations for agricultural practice. A valuable review and com-

pilation of this subject has been made by K. C. Beeson entitled "The Mineral Composition of Crops with Particular Reference to the Soils in which they were grown" (U.S. Dept. Agric. Misc. Pub. No. 369). The question is approached from two main aspects, namely, the soil characteristics associated with nutritional diseases in man and animals, and the various factors which affect the mineral composition of plants. In the first case, bone diseases, anæmias, goitre and selenium poisoning are among the instances discussed, while as regards the crops, fertilizers, climate, irrigation, age and part of the plant are shown to have an important influence on its chemical composition. More than six hundred references are quoted, which cover work carried out in various parts of the world. The publication concludes with extremely useful tables giving the chemical composition of a large number of crops, figures for many of the minor elements being included.

Rediffusion of Broadcasting over Electric Mains

In the report of the council of the Incorporated Municipal Electrical Association presented at the annual general meeting at York on June 12, one of the topics raised was broadcasting over the electric mains. In the last annual report it was intimated that in the event of legislation being promoted in this matter, the Association would press for the inclusion of a clause which would authorize electricity undertakers themselves to operate the rediffusion of broadcast programmes over their distributing mains if they so desired. Before the War, the business of rediffusion of broadcast programmes was a growing one and was, for some reason or other, outside the field covered by the electrical industry; but the Post Office was taking a special interest in the various rediffusion companies. The *Electrician* of June 13 says that it is probable that the Post Office holds the right to take over such wireless relays if it wishes, and that the further development of broadcasting over the mains might, without adequate protection, become a Government monopoly, with the added privilege of using, without cost to the Post Office, the already existing supply mains, which were put into the roads, etc., after long research and considerable expense by the electrical industry.

Earthquake of April 15 in Mexico

Further details are now available concerning the great earthquake which took place on April 15, 1941, in Mexico (see Nature, April 26, 1941, 507). It is stated in the news-magazine *Time* that at the tropical city of Colima, with a population of 20,000, the first shock caused the dam guarding the water supply to collapse, that it disrupted power lines and caused half the buildings in the town to collapse. The cathedral, rebuilt after the earthquake of 1932, was again destroyed, and during the night forest fires blazed round the town due to the scattering of the charcoal burning dumps by the earthquake. At least 36 people in Colima lost their lives. The shock was felt from Jalisco in the north to Oaxaca in the south, while in Mexico City just as lunch time was beginning, towers and signs swayed, church bells tinkled gently, windows rattled and pavements cracked. Mexico's tallest skyscraper, a seventeen-story office building at the corner of the Paseo de la Reforma and the Avenida del Ejido, shook and cracked and a five-story section of glass and facing stone collapsed. Fires broke out, one destroying the El Monte lumberyard after firemen had fought the blaze for six hours. No one was killed in Mexico City though 800,000 dollars worth of damage was done to property. Altogether the earthquake caused near 2,000,000 dollars worth of damage to property and at least 84 people were killed, including 27 at Tuxpan in the State of Jalisco.

The U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentre of this earthquake and its aftershocks from instrumental reports from twenty-one seismographic stations. The epicentre of the first earthquake at 19h. 9m. 53s. G.M.T. on April 15 was at lat. 18·8° N., long. 103·0° W., which is some 70 miles south-east of Colima, and the depth of focus normal. Strong aftershocks on April 15 at 23h. 42.6m. G.M.T. and on April 16 at 1h. 37·9m. G.M.T. had their epicentres slightly north of that of the main shock.

Beit Memorial Fellowships for Medical Research

At a meeting of the Trustees of the Beit Memorial Fellowships for Medical Research held on July 23 it was noted that out of the thirty present fellows thirteen have already been seconded at their own request for more direct service during the War, and that six others have undertaken research work for Government departments on problems arising out of the War.

The following elections of new fellows were made, all with permission for each fellow to be seconded at any time for war duties: *Senior Fellowship* (£700 a year) to Dr. T. R. R. Mann, to continue his work on intracellular metallo-protein compounds, expecially of red blood cells, at the Molteno Institute of Biology, University of Cambridge. *Fourth Year Fellowships* (£500 a year) to Dr. J. F. Danielli, to continue his work on the permeability of muscle fibres and of capillaries, at the Biochemical Laboratory, University of Cambridge; Dr. C. O. Hebb, to continue her studies of physiological problems in relation to high altitudes, at the Department of Physiology, University of Edinburgh; Dr. H. Lehmann, to continue his work on the influence of shock and of the suprarenal glands on glycogen synthesis, at the Biochemical Laboratory, University of Cambridge. *Junior Fellowships* (normal value £400 a year) to Dr. E. F. Gale, to study bacterial amine production as a cause of non-specific infantile diarrhœa, at the Biochemical Laboratory, University of Cambridge; Mr. W. Holmes, to study the regeneration of nerve fibres after injury, at the Department of Zoology, University of Oxford; Dr. M. F. Lockett, to identify renal pressor substances responsible for experimental high blood pressure, at the Pharmacological Laboratory, University of Cambridge.

Public Health in Venezuela

THE outstanding developments in Venezuelan public health since the establishment of the autonomous Ministry of Public Health and Social Welfare in February 1936 include the building up of a well-trained full-time staff, a tuberculosis control division with child and adult dispensaries in the capital and seventeen other cities, a school hygiene X-ray division, a national institute of puericulture, a malaria control division, a yellow fever preventive service, division of sanitary engineering and ankylostomiasis, and cancer and leprosy institutes. Among the more recent developments have been the creation of a Social Service Division in 1938, the opening of its school in 1940 and the increase in the number of beds in hospitals.

Institute of Fuel

MR. W. M. SELVEY has been elected president of the Institute of Fuel in succession to Sir John Greenly, as from October next. Mr. Selvey has been very closely identified for many years with the development of fuel economy in all forms, but more particularly in connexion with the electric power stations in Great Britain and abroad.

The Melchett Medal for 1941 has been awarded to Dr. Clarence A. Seyler, of Swansea, as some recognition of his work on coal and its constitution.

Sir David Milne-Watson, Bart., has been nominated president of the Fuel Luncheon Club for the coming session in succession to Lieut.-Colonel W. A. Bristow, who has occupied the chair for the past two years.

College of the Pharmaceutical Society

IT is good news that although the College of the Pharmaceutical Society has obtained temporary accommodation in Cardiff and the Departments of Nutrition and Pharmacology have been housed at the National Institute for Research in Dairying, Reading, research work is still going on. This is evidenced by the annual report for 1940 of the research departments of the College of the Pharmaceutical Society (pp. 30, Heffer and Sons). Items of interest are: the influence of cooking on the vitamin content of foods; the components of acriflavine; the structure of γ-sugars; the quantitative determination of cinnamon and cassia and methods of assay of prolactin, heparin and suprarenal cortical hormone.

The Marine Biological Laboratory, Plymouth

WE learn from the Secretary of the Marine Biological Association that the Plymouth Laboratory, which a few months ago sustained heavy damage through enemy action (NATURE, **147**, 411; 1941), has now been restored to working order. Extensive emergency repairs have been carried out, accommodation for research workers is once more available and there are limited opportunities for work at sea in the Association's motor boat. It has, however, been necessary to transfer the greater part of the library to other quarters, and only the recent volumes of current periodicals can now be consulted.

Comet van Gent (1941d)

A CABLEGRAM has been transmitted from Dr. W. H. van den Bos, Union Observatory, South Africa, announcing the discovery of a comet by Dr. H. van Gent, Bosscha Observatory, Lembang, on May 27.96965 U.T. At the time of discovery its position was, R.A. 18h. 01·9m., Dec. $-40°$ 07′, and its daily motion was 5m. 15s. west, 41′ north. It was diffuse, with central condensation or nucleus, and the tail was less than 1° in length. The magnitude was 11. An orbit has been computed by Dr. F. J. Bobone, the elements of which, and also an ephemeris, are given below.

T	1941 September 3·362 U.T.		
ω	84° 13′		
Ω	256 42		1941·0
i	95 10		
q	0·8925		

Ephemeris computed by Mr. L. E. Cunningham.

1941 U.T.	α (1941·0)	δ (1941·0)	Δ	r	Mag.
Aug. 2·0	13h 09·7m	+31° 20′	1·10	1·06	8·2
Sept. 3·0	12 24	41	1·4	0·9	7·5
Oct. 5·0	11 26	46	1·3	1·1	8·5
Nov. 6·0	9 25	50	0·9	1·4	9·5
Dec. 8·0	5 08	33	0·8	1·8	11·0
„ 24·0	4 06	19	1·1	2·0	12·5

The magnitudes have been computed from the sixth-power law.

Prof. Strömgren suggests that Comet Bernasconi-Zagar, discovered at Bologna on June 17, is probably Comet van Gent.

Announcements

THE Annual Congress of the Royal Sanitary Association of Scotland will be held in Glasgow on September 16–17.

A PAN-AMERICAN League against Cancer has been founded in New York under the presidency of Prof. Angelo H. Roffo, director of the Institute for Experimental Medicine at Buenos Aires.

THE subsidization of private growers of cinchona in India is being urged by the India Chemical Manufacturing Association, which points out that, if anti-malarial treatment is to be provided in India, at least 6 lakh lb. of quinine will be required annually. The present consumption is about 2 lakh lb., of which India produces about 70,000 lb., the remainder being imported from abroad.

A new national natural history society chiefly for scouts, guides and schoolboys under eighteen years of age, to be known as the Grey Owl Society, was recently formed at Haslemere, Surrey, by D. P. Faux, who is honorary secretary, the other officials being: *President*, Eric Hardy; *Editor*, P. Shaw Baker; *Hon. Treasurer*, Miss Watson. The society is to have a half-yearly journal called *Wild Life*, to publish instructive pamphlets, organize lectures, outdoor meetings, correspondence, an identification service and possibly nature study examinations. An explanatory booklet is now in the press. The secretary's address is 5 Lion Lane, Haslemere, and membership is also open to people over eighteen.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

"The Philosophy of Physical Science"

I HAVE been re-reading Sir Arthur Eddington's recent book with great admiration, but also with grave doubts as to whether his philosophical position is not wholly unsound. I think he employs the word 'epistemological' in at least two different senses ('epistemological-in-form' and 'epistemological-in-substance'), and the resulting confusion of thought is disastrous to his proposed new philosophy of science.

His main contention (pp. 57, 58) is that all those laws of Nature that are usually classed as fundamental, as well as the values of the constants of Nature, can be foreseen "from epistemological considerations, so that we can have *a priori* knowledge of them". As examples of such laws he mentions (p. 39) special relativity, the uncertainty principle of Heisenberg and the modified mechanics of indistinguishable particles.

The relativity principle was not in the first instance founded on, or even suspected from, epistemological considerations: it was founded on the Michelson-Morley and other experiments. After these had resulted in a sufficient number of failures to detect absolute velocity, Einstein proposed a hypothesis which can be expressed in a great variety of ways, as for example:

(*a*) The laws of Nature involve only relative velocities.

(*b*) It is impossible to determine an absolute velocity in space.

(*c*) It is meaningless to talk of simultaneity at distant points.

While the mathematical contents of these three statements are practically identical, their forms are very different. There is nothing epistemological in (*a*) and not much in (*b*), but (*c*) is distinctly epistemological-in-form. Eddington considers that (*c*) could have been foreseen epistemologically even "if the result of the Michelson-Morley experiment had not instigated a scrutiny" (p. 39). If he is right, then (*c*) is not only epistemological-in-form, but also epistemological-in-substance. But surely he is wrong. The Michelson-Morley experiment did more than instigate a scrutiny; it disclosed one of the 'brute facts' of Nature, and it is on this fact that proposition (*c*) depends for its very existence; if the experiment had not turned out as it did, there would have been no proposition (*c*). Thus (*c*) is not *a priori* knowledge in the sense of the rationalist philosophers, or even in the sense of Eddington, who defines *a priori* knowledge as "knowledge which we have of the physical universe prior to actual observation of it" (p. 24). In its substance (*c*) is just as empirical as (*a*) and (*b*); indeed all three statements comprise virtually the same substance—an interpretation of the Michelson-Morley etc. experiments.

There is a shorter cut to the same conclusion. If light travelled with infinite velocity, it would clearly not be meaningless to speak of simultaneity at distant points. Hence (*c*) includes, as the greater includes the less, the proposition that light travels with finite velocity. Can Eddington seriously claim that this is "knowledge which we have of the physical universe prior to actual observation of it"?

It is the same with Eddington's other instances, which are taken from the quantum theory. They can all be enunciated so as to be epistemological-in-form, but no matter in what form they are enunciated, their substance is empirical; their content is knowledge extracted from observation—in this case from studies of the spectra of black bodies and of atoms.

Eddington seems to me not to trouble about the substance of laws, but to tie the label "epistemological" on to every law which can be so enunciated as to be epistemological-in-form (as so many empirical laws can be). He then claims for his labelled laws an "altogether different status from physical hypotheses" (p. 39), as well as certain special properties peculiar to epistemological laws. He tells us, for example, that such laws "have a security that is denied to those that can only be reached empirically" (p. 19), and that "whatever is accounted for epistemologically is *ipso facto* subjective; it is demolished as part of the objective world" (p. 59).

These properties, it seems to me, can only be claimed for laws which are wholly epistemological-in-substance; that is, which are entirely free from any empirical ties with the outer world, and so are *a priori* in the sense defined above. Not a single one of the laws which Eddington labels as epistemological seems to me to qualify for this category.

After Eddington's last step quoted above, there is a clear road open to his conclusion that "the purely objective sources of the objective element in our observational knowledge are *life, consciousness, spirit*. . . . The purely objective world is the spiritual world; and the material world is subjective in the sense of selective subjectivism" (p. 69). But is it not obvious that we cannot attain such far-reaching results merely by stating the results of experiment in such a way that they are epistemological-in-form?

J. H. JEANS.

Park House,
Wanstrow,
Somerset.
June 20.

IT is difficult to answer Sir James Jeans within the space of a letter; but I will begin with his statement (*c*). This is simply a statement of fact. Except in cosmological investigations, quantitative statements depending on distant simultaneity are meaningless because the reckoning has been left undefined. In the last thirty years distant simultaneity has been *by-passed*; and there is now no inducement to find a meaning for it even if we could. Among other consequences 'intrinsic similarity' of two systems necessarily means that they are related by a Lorentz transformation, that being the only criterion of similarity which does not presuppose a definition of distant simultaneity. The definition of similarity provides the norm from which are reckoned the strains which describe various kinds of dissimilarity.

In this way the Lorentz transformation has become an ingredient in the comprehensive scheme of formulation of knowledge, covering molar and microscopic physics, which comprises the equations and constants commonly classed as 'fundamental'.

Thus far I have been considering method, not observational facts. I agree with Sir James Jeans that the Michelson-Morley experiment discloses "one of the 'brute facts' of Nature". Let us try to express this 'brute fact' not in the terminology of 1887, or even of 1905, but as it appears in 1941. To say that the experiment will give a null result if strains are properly eliminated has become a tautology. The new fact is that, with the experimental precautions adopted, strains *are* eliminated.

Facts of this kind are of immense importance for progress; but they occur in other parts of physics, and we do not make a song about them. The pessimist may say: How can I keep an eye on all possible sources of disturbance, near and distant, visible and invisible? The optimist attends to a few major sources and trusts that the rest will balance out. Sometimes the optimist is right, sometimes the pessimist. In astronomy the optimist has assumed that the stars really are in the direction in which we see them—that their light rays take a straight course to the earth. The pessimist might reflect that, unless the light rays go a great deal straighter than they do in the gravitational field on the earth, they will tie themselves in knots in interstellar space. His fears are groundless, and it is of immense importance to discover that they are: but I do not know of any astronomical text-book which mentions this. The laying of bogies is an important side of progress; but it is not the practice to associate with the fundamental laws of physics an obituary of bogies.

If, following Jeans, we are to distinguish between the form and substance of a law, the substance is, I suppose, concerned with what obeys the law. In elementary cases we can indicate the substance by pointing—we point to certain objects in the sky and say that those are what Kepler's laws apply to. But as physics has grown more complex a change of method has occurred, which I think Jeans does not take into account. Description has been substituted for pointing. The change was scarcely avoidable, since we have to indicate not only an object but also the conditions in which the effects predicted by the law would occur undisturbed. The elements in the description can only be defined by their properties, that is, by the laws they obey; so that we find ourselves chasing our own tails in a purely formal system. Jeans's objection is that we know a great deal about the universe which is not mere tail-chasing. I answer: Yes; but that is not the knowledge epitomized in the existing scheme of fundamental laws and constants. Their function is to supply a system of formulating it.

I have been considering what the Michelson-Morley experiment discloses, not what it might have disclosed. Perhaps I should also consider the situation which would arise if the experimenters have let us down badly and the true result is that which Michelson originally expected. In the present terminology we should say that there is a strain depending systematically on the velocity. I think that (after gathering up the wreckage of present-day theory) we should find ourselves faced with a universe far more complicated than we have lately imagined: so that relatively we should be thrown back many centuries, and much further investigation would be necessary before we could see how the scheme of epistemological law applied. Another possibility is that it might be sufficient to introduce an extra law governing the strains and whatever was the cause of them. Presumably this would be a truly objective law—the first to be discovered. Whilst my scientific epistemology would be unaffected, the conclusions referred to in the last paragraph of Jeans's letter would be upset, since they are a commentary on the fact that no truly objective law has been found. However, so long as the effect is only imagined and not discovered, I need feel no apprehension.

A. S. EDDINGTON.

The Observatory,
Cambridge.

Reactivity of the Sulphur Linkage in Animal Fibres

MAKING use of a reaction discovered in this laboratory[1], Elöd, Nowotny and Zahn[2] claim to have shown that disulphide bond breakdown is neither an essential preliminary to the setting of strained animal fibres, nor a necessary cause of supercontraction. Wool fibres were heated with water in presence of mercury at 80° C., hydrogen sulphide being liberated and mercuric sulphide formed as a result of disulphide bond breakdown:

$$R.CH_2.S.S.CH_2.R + H_2O = R.CH_2SH + R.CHO + H_2S.$$

Although 45 per cent of the total sulphur was removed in 19 days, suggesting that 90 per cent of the disulphide bonds were hydrolysed, the fibres showed no tendency to contract in either boiling water or boiling hydrochloric acid at *p*H 2, and their setting power (in an unspecified medium) was unimpaired.

The failure of the mercury-treated fibres to show supercontraction might be due to the occurrence of setting reactions in the unstretched fibres during the prolonged heating in water at 80° C., especially as mercury compounds have been shown to be specially effective in promoting cross-linkage formation[4]. Elöd himself refers to the tanning action of the mercuric sulphide[2], but if cross-linkage formation is invoked to explain the absence of supercontraction, the difficulty of accounting for unimpaired setting properties becomes more acute. There can be no doubt, therefore, that if Elöd's observations are correct, the present theory of the chemical mechanism of permanent set[3] is invalidated. In consequence, it seemed justifiable to re-examine the properties of mercury-treated fibres.

Because of its higher sulphur content, human hair was used in preference to wool, in order to prolong the reaction with water and allow the course of disulphide bond attack to be followed more readily. After purification with alcohol, ether and distilled water, the fibres were heated for several days at 80° C. with distilled water and purified mercury in a quartz tube. Fibres were removed at intervals and their setting power determined in the usual way, each fibre being stretched 40 per cent in cold water and then set by immersion in boiling 2 per cent borax solution for 30 minutes. The set retained by the fibre after various times of release in boiling water was determined by measuring its air-dry length at intervals, drying being allowed to proceed in absence of tension. Typical data are given in the accompanying table, from which it is clear that the ability of

animal fibres to acquire a permanent set decreases with increasing time of heating with water and mercury at 80° C.

Time of treatment with water and mercury at 80° C.	Percentage set after release in boiling water for: 0 min.	2 min.	15 min.	30 min.	60 min.
Untreated	40·2	24·0	22·3	22·5	22·2
6 d. 2 hr. 15 min.	40·4	19·0	17·6	17·4	17·1
8 ,, 23 .. 6 ,,	40·2	15·9	15·2	14·9	14·4
13 ,, 3 .. 50 ,,	40·3	12·9	12·2	12·0	11·5
22 ,, 2 .. 30 ,,	40·3	2·9	1·6	1·1	0·5

In accordance with setting theory, too, the treated fibres showed an increased power of supercontraction in boiling 2 per cent borax solution. For example, fibres which had been treated for 22 days contracted 42 per cent after 40 minutes boiling, whereas the length of untreated fibres remains unaltered under similar conditions. Contrary to Elöd's observations, therefore, supercontraction is promoted and set prevented when sulphur is removed from animal fibres by the combined action of water and mercury at 80° C. The present conception of the chemical mechanism of permanent set[3] remains valid, and the theoretical superstructure which Elöd has erected need not be discussed.

J. B. SPEAKMAN.

Textile Chemistry Laboratory,
University,
Leeds. June 30.

[1] Speakman, J. B., NATURE, 132, 930 (1933); Speakman, J. B., and Cooper, C. A., *J. Text. Inst.*, 27, T 191 (1936).

[2] Elöd, E., Nowotny, H., and Zahn, H., *Koll. Z.*, 93, 50 (1940).

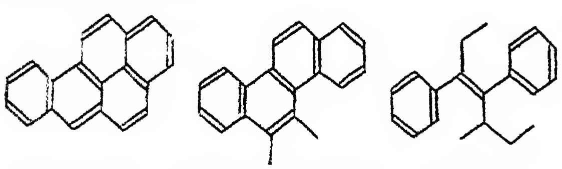
[3] Speakman, J. B., *J. Soc. Dyers and Colourists*, 52, 335 (1936); Speakman, J. B., and Whewell, C. S., *ibid.*, 52, 380 (1936); Speakman, J. B., and Stoves, J. L., *ibid.*, 53, 236 (1937).

[4] Speakman, J. B., Stoves, J. L., and Bradbury, H., *J. Soc. Dyers and Colourists*, 57, 73 (1941).

Carcinogenic Agent without the Condensed Carbon Ring Structure

IN an earlier publication[1] the formula of the highly active synthetic œstrogenic analogue, stilbœstrol, was contrasted with those of œstrone and chrysene. The figures in this earlier letter in NATURE indicated that by ring closure in the case of stilbœstrol a condensed carbon ring compound similar to œstrone on one hand and to chrysene on the other could be obtained. Since all the known carcinogenic hydrocarbons possess the condensed carbon ring structure, it was decided, by analogy with œstrone, to see if it were possible to break down the condensed ring structure of the carcinogenic hydrocarbons without losing all carcinogenic activity.

Two groups of twenty-five adult stock male mice, one group of coloured, the other of albino mice, have been painted twice weekly with a 0·3 per cent solution of α-ethyl-β-*sec*-butylstilbene in benzene. Fig. 1 indicates how this substance can be derived from either benzpyrene or dimethylchrysene by fissure of the rings.

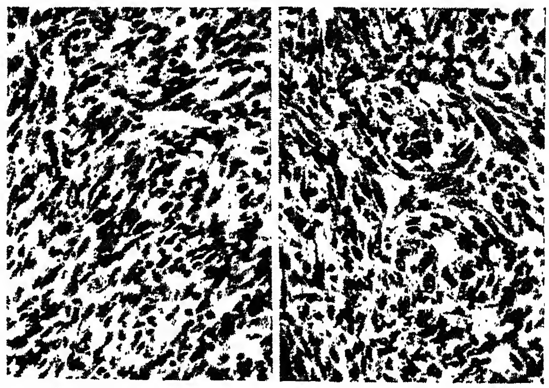


BENZPYRENE DIMETHYLCHRYSENE α-ETHYL-β-*sec*-BUTYLSTILBENE

Fig. 1.

Two tumours have developed in these groups. One of the seven coloured mice (*CM* 160/40) surviving after 12 months painting, had a tumour on the edge of the painted region at the back of the neck. It grew more rapidly than was expected, reaching a size of 2 cm. × 2 cm., and became necrotic. A second tumour was found in one of the thirteen albino mice (*CM* 44/40) surviving after 15 months painting. This was a slow-growing tumour situated subcutaneously on the rump 2 cm. distant from the painted area. At autopsy it was hard and 1·5 cm. × 0·5 cm. in size. In neither case were any metastases found.

Histologically, the two tumours were very similar (see Fig. 2), being spindle-celled and malignant. The first one was a spindle-celled carcinoma, the second a sarcoma. Attempts to transplant the first were unsuccessful, but fragments of the sarcoma were implanted in ten stock albino mice and, at the time of writing, two months after implantation, tumours have developed in five of the ten. The largest tumour (2 cm. × 1 cm.) has been sectioned and proved to be similar to the parent sarcoma.



CM 160/40 (×200) *CM* 44/40 (×250)

Fig. 2.

A further group of fifty mice is now being painted with the same compound in an attempt to confirm the results, and other chemically related compounds are being investigated. If the results are confirmed, we believe that this is the first instance of carcinogenesis associated with painting a hydrocarbon without a condensed ring structure.

No positive results have been obtained by painting mice with diphenylhexane, diphenylhexadiene or diethylstilbene for shorter periods (6–9 months) in the same way; and no tumours were found on painting groups of twenty-five coloured mice twice weekly with 0·3 per cent acetone solution of 4 : 4′-dihydroxy-αβ-diethylstilbene (stilbœstrol), 4 : 4′-dihydroxydiphenylhexane (hexœstrol) or 4 : 4′-dihydroxystilbene for similar short periods. Stilbœstrol when given by this method was unexpectedly toxic, and none of the mice survived for more than three months.

E. C. DODDS.
W. LAWSON.
P. C. WILLIAMS*.

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.

* Beit Memorial Research Fellow.

[1] Dodds, E. C., Golberg, L., Lawson, W., and Robinson, R., NATURE, 141, 247 (1938).

Stimulation of Neuron Proliferation by Means of Growth Hormone

IN further investigation of the theory I have already outlined[1,2] that by means of the growth hormone preparation it may be possible to stimulate artificially the proliferation of prospective cerebral neurons in mammals, I have used 385 albino rats in an attempt to improve the level of the psychical functions of the animal.

The rats were subjected in pregnancy to subcutaneous injections of growth hormone preparation 'Antuitrin G' and 'Phyone'. The offspring investigated at birth showed an increase of 18·7 per cent in body weight, 36 per cent in cerebral hemispheres weight, 21 per cent in thickness of the cerebral cortex, 70·4 per cent in volume of the cortex, 9·27 per cent in density of cells, and 86·5 per cent in number of cells per volume of cortex, as compared with the controls. All these increases are statistically significant.

A certain number of animals reached maturity, and proved to show an increase of 14·8–27·6 per cent in cell density, and 38–40·6 per cent in total number of cortical neurons, as compared with the controls. These increases are statistically significant.

It is concluded that in mammals the growth hormone preparation administrated in pregnancy does increase the number of cortical neurons in the offspring.

A full report on this work will be published elsewhere.

S. ZAMENHOF.

Work done in the Dept. of Animal Care,
School of Physicians and Surgeons,
Columbia University,
New York City.

[1] Zamenhof, S., "On Present Possibilities of Increasing the Higher Functions of the Cortex Through Artificial Changes in Its Architectonic," The Science Press Printing Co., Lancaster. 1940.
[2] Zamenhof, S., *Growth*, 5 (June, 1941).

The Hamburgh Parsley

THE Hamburgh parsley, known also as the large-rooted parsley, turnip-rooted parsley or parsnip-rooted parsley, has been developed on the Continent for its root instead of the usual leaves. It is a vegetable which deserves much wider use in Great Britain both for its pleasant flavour, which most nearly resembles celeriac, and as a particularly rich source of vitamin C during the winter months.

There are two varieties, the late, with long thin roots, and the early, which forms a compact root like a short thick parsnip. The latter is the more useful type and is the form on which these notes are based. At Cambridge stocks have been grown from Danish, French and German seed, the Danish producing the best-shaped roots. The roots are a very pale yellow colour, almost white, and they form an excellent vegetable either boiled, used in vegetable stew or soup, or grated and eaten raw.

Cultivation is the same as for parsnips, but the roots are easier to dig and remain free from canker. From a sowing made on April 18, usable roots were obtained in October and remained in good condition when stored until the end of the following April. The roots appear to be unaffected by frost and can be left in the ground and dug as required for use, or can be stored in a clamp. No figures for the rate of cropping have been obtained, but it should be reasonably high judging by the appearance of roots lifted from observation rows. The Hamburgh parsley will grow on poor soil, having thrived on the hot dry gravel at Cambridge.

The greatest merit of this vegetable as a war-time crop is its rich content of vitamin C which is available during the winter months. It has been found by a nutritional laboratory that roots which had been stored for 5 months still contained about 21 mgm. of vitamin C per 100 gm., a much higher value than is known in any root vegetable except swedes.

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Plankton as a Source of Food

MANY will have read with interest the recent proposals[1] concerning the possible use of plankton for human or livestock food. There is, however, an entirely different aspect of the subject which ought to be considered and would at least in one connexion be of far easier application. I refer to the possible use of plankton—especially freshwater phytoplankton—for *plant* nutrition, and the 'connexion' is the small vegetable gardener who has to water his plants. If he does this repeatedly or at least frequently in what is often the easiest way, namely, from open tanks or pans or from the A.R.P. buckets we are supposed to have outside our doors, he may be adding a very useful amount of nutrient matter to the soil, at least during periods of plankton 'maximum'. In hot sunny weather, just when watering is most necessary, great algal activity (which may turn water green in a day) may be maintained week after week and used almost nightly by merely leaving the green or brownish investment on the inside of the vessel intact when fresh water is added.

It seems probable that in these present times when farmyard manure is often impossible to obtain, such frequent planktonic additions, the component individuals of which often go on growing and dividing on or below the surface of the soil but ultimately will be washed down and decomposed, would go at least some way towards remedying the deficiency—without extra trouble or expense to the gardener. Only a sunny situation and wide open vessels are necessary, and sometimes the addition of a nitrogenous and phosphatogenous solution (for example, a very few drops of liquid manure).

It has been my intention for some months past to experiment along these lines and find out if the suggested benefit is really considerable, especially under other than optimal conditions; but as I have as yet had no opportunity to do this with proper controls, and am unlikely this year to have the time even to read all the pertinent literature[2], I record these ideas and intentions in the hope that they may be taken up and made use of by someone else. Other, connected possibilities which have come to mind, but about which I can find no published *ad hoc* research, I would gladly impart to or discuss with any responsible person who may be interested.

NICHOLAS POLUNIN.

The Herbarium,
Department of Botany,
University of Oxford.
July 23.

[1] *The Times*, May 6, 1941, and NATURE, 147, 695, 808 (1941).
[2] Useful bibliographies are given in *J. Ecology*, 19, 266 (1931) and 28, 491 (1940); see also *Ann. App. Biol.*, 26, 165 (1939).

SURFACE SOIL THICKNESS AND COTTON DEVELOPMENT

By Dr. A. Sreenivasan,

Institute of Plant Industry, Indore

In profile studies with the black cotton soil in Malwa, it has been observed that the thickness of the productive surface layer differed appreciably even between adjoining rich and poor fields. Often, the nature of the surface soil also varied, particularly in regard to openness, permeability and crumb structure. It therefore appeared probable that the friable loose surface soil in a field was closely associated with its fertility.

The normal drainage water from fields during rains removes with it a certain amount of the finer fractions of the upper soil layers, but beyond this, it is essential to conserve the surface soil from erosion losses. A knowledge of the depth of the surface soil which it is necessary to conserve will be of value in determining the efficiency of erosion control.

During the 1939 kharif season, a small plot (8 ft. × 8 ft.) experiment was carried out to ascertain what depth of the surface soil is optimum for cotton development, and whether it is enough to conserve the existing soil of a field or whether importation of surface soil from a rich field will be of any benefit to a poor field.

The test was carried out on the Institute fields, 12*D* and 27*S.E.* The former is a field of medium fertility and is well drained, while the latter is a badly drained field with very poor crop growth. The rich surface soil required for the experiment was taken from field 42*N*. Addition of average, loose, hand-gathered surface soil from the same field was made in thicknesses of 1, 2, 3, 4 and 5 in. respectively. Addition of surface soil from the rich field was made in thicknesses of 2 and 5 in. only.

There were five randomized blocks in each of the two fields with eight plots per block. Experimental plot size was 6 ft. × 6 ft. containing six rows of plants one foot apart, thus leaving a non-experimental margin of one row on each side and one foot at each end of the plot. There were 3-ft. paths between and all round the plots which were edged with bricks. The seeds (variety *Malvi* 9-20) were sown by dibbling.

Table I.

	Control-untreated	Thickness in inches of surface soil added from: Same field					Rich field	
	(1)	One (2)	Two (3)	Three (4)	Four (5)	Five (6)	Two (7)	Five (8)
Well-drained field (12*D*)								
Yield of seed cotton (in ounces)	34·8	55·3	63·3	58·0	57·0	58·0	44·3	77·8
		Critical difference ($P = 0{\cdot}01$) = 4·6. Order of merit: (8) (3) (2) (4) (5) (6) (7) (1)						
Poorly drained field (27 *S.E.*)								
Yield of seed cotton (in ounces)	9·5	16·8	16·0	17·0	24·5	28·3	15·0	24·0
		Critical difference ($P = 0{\cdot}01$) = 2·5 Order of merit: (6) (5) (8) (2) (3) (4) (7) (1)						

Table II.

Loose surface soil from:	Carbon per cent	Nitrogen per cent	Available K_2O per cent	Available P_2O_5 per cent	Exchange capacity m.e. per cent	Pore space c.c. per cent	Structural coefficient	pH
Poorly drained field (27 *S.E.*)	0·407	0·064	0·0037	0·014	38·0	51·6	0·44	8·6
Well-drained field (12*D*)	0·436	0·076	0·0039	0·013	38·8	53·9	0·52	8·4
Rich field (42*N*)	0·604	0·077	0·0044	0·013	40·1	55·8	0·58	8·7

The yields of seed cotton for the different treatments are given in Table I.

Addition of loose surface soil from the same field increased the yield of cotton in both the fields, but while in the well-drained field the best result is obtained with the addition of a 2-in. layer of surface soil, the poorly drained field shows in general increasing differences in yield with increased additions of surface soil, a 5-in. layer giving the maximum yield. Lack of proper drainage naturally results in surface wash during periods of heavy rainfall and consequent loss in the fertility of the field (*cf.* the yield figures for the control plots of the two fields). Besides, the difference between the two fields in their response to treatments also shows the relative richness of their surface soils. This fact is further borne out by the results of laboratory examination of these surface soils (Table II).

Addition of surface soil from the rich field also increased the yield significantly in both the fields, the response being better with the greater thickness. But, considering the cost of importation, this is not likely to be more profitable compared to addition of soil from the same field.

These results bear out the value of the conservation of surface soil that may be achieved by erosion control.

FORESTRY IN NYASALAND

FROM the annual report of the Forestry Department of the Nyasaland Protectorate for the year ending December 31, 1940 (Govt. Printer, Zomba, Nyasaland, 1941), it appears that a happy relationship has been established between that Department and the Agricultural Department. The Forestry Department has to some extent undertaken duties which bring it into direct relationship with the agricultural habits and practices of the local population. The Conservator reports that during the year the Provincial Agricultural Officer visited the southern course for special discussions, and the Director of Agriculture addressed the Foresters at the close of the course. These courses are annual ones given to the subordinate forest staff by divisional forest officers and lasting 10–14 days. The aims of the forestry policy in Nyasaland have been already discussed in NATURE.

The formation of village forests has proved a most important departure in the Protectorate, for they have caught the imagination. It is stated that the number of registered village forest areas has now reached 4,677 and that the majority are well cared for by the headman and villagers. In some of the earliest formed, systematic thinnings are now being undertaken with assistance from the district forestry staffs. It will be noted that this management is on the same lines as practised in the management of the communal forests in France. But a still closer connexion between the forest staff and the agricultural community exists through the participation of the former in land use problems and in activities to introduce simple reforms in the agricultural methods of the people. It is said that results have been excellent in parts of the Southern Province and that whole communities have changed over from mound planting (on hill-sides, productive of serious erosion) to ridge planting on the contour. Hill slope closure and stream bank protection are serious questions in parts of the Protectorate, and a plea for increased agricultural production has emphasized the need for much better control by native authorities over the opening up of new land for cultivation. For example, one of the commonest phases of these unchecked, ignorant cultivation practices it is stated is that "in some regions very steep hill slopes, of only ephemeral utility for agriculture, are still being cleared for planting maize".

It appears only fair to a forest staff to point out that, so long as dangerous activities of this kind are allowed by the administration to be practised unchecked, the danger to the Colony concerned as a whole may be so great as to render nugatory the efforts of a Department in obtaining sanction to the formation of forest reserves with a view to their professional management ; or even to the future success of the village forests, to the inauguration of which the Conservator of Forests in Nyasaland has devoted so much energy with such refreshing and creditable results.

OXFORD MEETING OF THE WORLD CONGRESS OF FAITHS

BY SIR FRANCIS YOUNGHUSBAND, K.C.S.I., K.C.I.E.

RECONSTRUCTION is in the air : the need for building a New World Order ; and the need for a sound spiritual basis on which to build it. This was the subject discussed at the meeting held at Oxford during June 27–July 2 of the World Congress of Faiths. The main idea of the Congress is to promote the spirit of fellowship and to promote it through religion ; not through one religion only, but through all religions working in collaboration and in concert, each retaining its own individuality, its own special forms and beliefs, but all willing to work with others in the great world-reconstruction now before us.

With this as its general aim, the World Congress of Faiths had for its special subject for discussion at this sixth annual meeting the interdependence of religion and the political, economic, social and educational aspects of the New World Order.

The Congress was officially welcomed to Oxford by the University. The inaugural meeting was addressed by the chairman of the Congress, Sir Francis Younghusband, by Señor Madariaga, Sir Hassen Suhrawardy (Muslim adviser to the Secretary of State for India) and the Rev. Canon Grensted. Others who spoke at the sessions of the Congress included Lord Samuel, Dr. Gilbert Murray, Mr. Yussuf Ali (translator of the Koran into English), Lord Davies, Diwan Runganadhan (another Indian adviser to the Secretary of State for India), Baron Palmstierna (formerly Swedish Minister to the Court of St. James's), the Warden of All Souls, Prof. W. Adams, and Miss Maude Petre, a well-known Roman Catholic writer.

Both the addresses and the discussion on them were on a high level. As a result of the meeting it was decided to invite the principal leaders in the Hindu, Buddhist, Jewish, Confucian and Muslim worlds to make pronouncements so far as possible on similar lines to that issued by the Pope and acceded to by the leaders of the Roman Catholic, Anglican and Free Churches in Britain. But the Congress also passed a resolution advocating the addition of a

clause favouring freedom of religious worship and expression.

It was evident to those who had attended previous Congresses, as well as the present, that distinct progress had been made. The Congress is now well established and able to draw support from the most influential persons in the country. Moreover, a growing cohesion among its members was noted, and it is safe to predict that some years hence a meeting of the Congress on a far greater scale might be held. There would necessarily be a meeting of the present belligerents to settle the terms of peace between them. After this limited conference, a more general conference would probably follow at which representatives from most of the peoples of the world would assemble to decide upon the future political structure of the New World Order, whether a reformed League of Nations or some type of federation. This would be an opportunity which should be seized. The World Congress of Faiths should organize a meeting of the most prominent representatives of all the great world religions to devise means by which the political New World Order may be given that spiritual drive and that steady and sustained spiritual support without which it can never endure. Annual meetings of the Congress will be held as heretofore; but the greater meeting some years hence will be the goal towards which they will deliberately be made to tend.

MATHEMATICAL PROBLEMS IN SEISMOLOGY

A. BLAKE has recently directed attention to many outstanding problems in mathematical seismology (*Trans. Amer. Geophys. Union*, 1940). The following problems are, more particularly, mentioned: (1) Problems in the theory of seismic waves due to inhomogeneities in the media and other causes, and to new methods available for the study of the interior of the earth. (2) Problems of instrumental seismology including the new strain meter and rotation seismograph. (3) Problems relating to the complexities encountered in determining the response of engineering structures to the motion of a strong near earthquake. (4) Problems of statistical seismology, especially the periodicity problem. In many cases Blake states that seismological calculations may be performed by machines such as the differential analyser and punched card machines.

Concerning strong-motion problems, Blake says that the analysis of the response of a structure into characteristic or normal components satisfying linear equations depends on the treatment of the strain-energy function as quadratic. But the purpose of investigating the response to destructive earthquake motions requires consideration of strains much exceeding the limits within which Hooke's Law remains valid. According to the author the linear theory can then only be used as a first approximation and the effects of the various components of ground motion cannot be treated separately. The Rayleigh dissipation function may be important, but the case of small damping including the existence of normal modes of oscillation has been encountered in the case of buildings, bridges and tank towers. The paper will act as a signpost towards further progress in mathematical seismology.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER OF GENERAL SCIENCE SUBJECTS (PHYSICS AND CHEMISTRY), AND A TEACHER OF MATHEMATICS—The Principal, Luton Technical College, Park Square, Luton (August 9).

DIETITIAN—The Secretary-Superintendent, Middlesex Hospital, London, W.1 (August 9).

ASSISTANT INSPECTOR OF SCHOOLS—The Education Officer, Education Office, Katharine Street, Croydon (endorsed "Assistant Inspector of Schools") (August 11).

ASSISTANT SECRETARY FOR EDUCATION—The Secretary for Education, Education Offices, 6 Lampton Road, Hounslow, Middlesex (August 23).

COLLEGE LIBRARIAN—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 13).

PROFESSOR OF MATHEMATICS—The Registrar, University College of Swansea, Singleton Park, Swansea (September 13).

PART-TIME LECTURERS AND INSTRUCTORS IN ALL SUBJECTS OF MECHANICAL, ELECTRICAL AND PRODUCTION ENGINEERING—The Principal, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

John Innes Horticultural Institution. Thirty-first Annual Report for the Year 1940. Pp. 20. (London: John Innes Horticultural Institution.) [217

The British Council. Report for 1940–1941. Pp. 176. (London: The British Council.) [217

Transactions of the Hertfordshire Natural History Society. Vol. 21, Part 3: Sawflies of the Berkhamsted District, with a List of the Sawflies of Hertfordshire and Buckinghamshire, and a Survey of the British Species (*Hymenoptera Symphyta*). By Robert B. Benson. Pp. 177–232. (Hertford: Stephen Austin and Sons, Ltd.) 5*s*. [217

Other Countries

Report and Accounts of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein) for the Year ending 31st December 1940. Pp. 20. (Kirstenbosch: National Botanic Gardens.) [147

Contributions from the Biological Laboratory of the Science Society of China, Zoological Series. Vol. 13, No. 9: Study of the Euect of Cerebral Cortical Lesion on the Respiratory Exchange and its Associated Phenomena of the Albino Rat (*Mus norvegicus*). By Y. J. Wu, T.L. Chiu and C. Ping. Pp. 101–120. 40 cents. Vol. 13, No. 10: On the Digestive Enzymic Actions in the Gut of the Earthworm, *Pheretima*. By Y. Chiung Puh. Pp. 121–134. 80 cents. Vol. 14: Taxonomy and Faunal Relations of the Limnitic Oligochæta of China. By Y. Chen. Pp. 132. 13 dollars. Vol. 15, Part 1: Study of some Forest Insects of Nanking and its Vicinity, Part 4: Observations on the Pine Moth (*Dendrolimus punctata* Walker). By C. P. Miao. Pp. 16. 80 cents. Vol. 15, Part 2: Compounds related to the Natural Oestrogens: γ-Cyclopentyl-δ-(4-Hydroxyphenyl)-$\Delta\gamma$-Hexene, γ-(2-Methyl Cyclopentyl)-δ-(4-Hydroxyphenyl)-$\Delta\gamma$-Hexene. By Dr. Huang-Minlon. Pp. 17–28. (Shanghai: Science Society of China.) [177

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 204: Numerical Calculation of Power Variation with Altitude in a Naturally Aspirated Engine by means of J.S. Diagrams. By Keikichi Tanaka, Osamu Tamura and Osamu Konisi. Pp. 32. 50 sen. No. 205: On the Subsonic Flow of a Compressible Fluid past a Symmetrical Joukowski Aerofoil. By Susumu Tomotika and Hazimu Umemoto. Pp. 33–126. 1.30 yen. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) [177

Report of the Institute of Scientific Research, Manchoukuo. Vol. 4, Nos. 19–20: On the Fatty Oil of Awa (*Setarica itarica*, Beauv.) Bran., by Mano Yoshikatsu; On the Vitamin Contents of Dried Mushrooms produced in Manchoukuo, by Kozo Kawakami and Hideo Miyayoshi. Pp. 393–404. (Hsinking: Institute of Scientific Research.) 25 sen. [177

Baltische Geodätische Kommission. Sonderveröffentlichungen, Nr. 8: Messung der Grundlinien Örebro und Värnamo in Schweden im Jahre 1938. Von U. Pesonen. Pp. 26. Sonderveröffentlichungen Nr. 9: Tafeln zur Übertragung geographischer Koordinaten auf dem Internationalen Erdellipsoide im Bereich 35° bis 71° Breite. Pp. 54. (Helsinki: Baltische Geodätische Kommission.) [177

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NATURE

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REORGANIZATION OF THE NATION'S WAR EFFORT

THE concern with the organization of production and the strategy of the War, both diplomatic and military, which found expression in the debates on the campaign in Crete and more recently on war production arises entirely from the desire to strengthen the hands of the Prime Minister, from the general belief that insufficient use is still being made of our resources of materials and men, and that, great war premier as he is, he cannot win the war without long-term strategic plans or unsupported by the application of the keenest critical minds the Empire can supply. The Government showed a lamentable lack of appreciation of this position in a recent debate on production when the Minister of one Department and the Parliamentary Secretary of another were left to meet criticisms which came from all parts of the House of Commons and raised questions far wider than any departmental issues. The insistent call for a better distribution of effort, more effective planning and a more scientific method of organization was deliberately ignored, nor can it be said that this call was fairly met by the Prime Minister in his statement opening the subsequent debate on July 29.

Such neglect is disservice to the Prime Minister himself. Appreciation of the magnificent service he has rendered and continues to render to the cause of freedom throughout the world is in no way diminished by a growing conviction that his service would become even more invaluable if he could be relieved of some of the heavy burdens the present system and organization place upon his shoulders. Moreover, the changes recently announced—the appointment of an advisory committee to the Production Executive and the attachment of the regional boards to the Production Executive—like the appointment of Lord Beaverbrook as Minister of Supply and Mr. Morrison's arguments against a Ministry of Civil Defence are suggestive more of shreds and patches than of a concerted policy and the formulation of a grand strategy. Taken with the rather petulant reply of the Prime Minister himself to questions regarding the recent appointment of Mr. Oliver Lyttelton as Minister of State resident in the Middle East, they are calculated to arouse, rather than to dispel, public misgivings.

That the time has come for recasting strategy and replanning the War is widely believed. Parliament clearly means to see that the Prime Minister is provided with the best political, diplomatic, administrative, industrial and military machine the Empire can create. It is determined that the burden is no longer to be on one man alone, and the demand for a small War Cabinet of men of highly developed critical faculties, moral courage, clear and imaginative minds and a good working knowledge of strategy and industrial planning grows stronger every day. Only from such a Cabinet can we look for what is the more imperative as help from the United States increases—a

definite decision as to the kind of war we mean to fight, how and where we mean to fight it, and the forces required for success.

Such decisions are essential to the devising of an adequate and flexible plan and to the organization of the home front whether for civil defence or production. They cannot be expected of the bureaucratic mind and there must be utter ruthlessness in sweeping away the type of official who regards the State or some department of it as his own affair, in which no one outside has any right to interfere except under his orders. That this is the temper of the nation was shown clearly in the recent debates on production with their demand for leadership. Examples could be multiplied over almost the whole field of national endeavour to show how for lack of imaginative and constructive leadership opportunities are being missed, enthusiasm damped, and the national effort checked of its full power.

In these circumstances, Lieut.-Colonel Clive Garsia's "Planning the War", just published as a "Penguin Special", is of particular interest, and may well serve to focus constructive thought upon the aims of Allied strategy, the means by which they are to be achieved and the organization of all our resources to that end. Obviously, there is much that the Government cannot disclose of both planning and strategy, but there are too many signs of the absence of planning where it should be evident for uneasiness in this respect to be lightly dismissed. A trenchant article by Sir William Beveridge, for example, in *The Times*, pointed out that the formation of a national fire-fighting service was at least six months overdue when it was initiated, and disposed convincingly of Mr. Morrison's arguments against a Ministry of Civil Defence.

That co-operation between existing Ministries and local authorities is still imperfect, that the degree of readiness in different areas does not correspond to the degree of danger, and that the Fourth Arm of our defences needs a single head as much as the other three arms is scarcely questioned by those who have experience of severe air attack. A similar impression prevails in the field of production through failure of the Government to use its compulsory powers and give positive direction and not merely advice, for example, in the numerous problems which arise in the concentration of industry and the direction of labour and enterprise from distribution or non-essential work to the war production industries. Indeed, the omission to take the nation into its confidence, to explain exactly why certain changes in occupation, in habit, or diet are required and then firmly and impartially enforce them, whether the use of brown bread in place of white, the discouragement of inefficient forms of food production or conversion, such as pig-keeping, poultry and eggs, the allotment of shipping space to non-essentials, or the elimination of retailers whose trade is too small for economic distribution, is doing more harm to the national morale than the Government realizes or admits.

Consciousness of this danger is the true source of some of the concern regarding the Ministry of Information itself, but uneasiness at the co-ordination of our war effort is widespread. Too many problems of civil defence, priorities, fuel, agriculture, and so on, appear to be handled on departmental lines with little indication of relation to an overruling plan and strategy. Evidence of waste of man-power and materials is widespread, and there is growing impatience at excessive leniency towards offenders in such matters as absenteeism, mismanagement and offences against rationing. Too often the people hunger for leadership and are not fed.

It is not to be expected that the incomparable leadership of the Prime Minister should be all that is provided. Something of that quality must reach down from him through all ranks and to all sections of society. Nor is the long-range planning or even the medium-range planning essentially the task of a War Cabinet. That should rightly be delegated to professional subordinates whose special and sole business it is, whether industrial, naval, military, scientific or political. This is the first characteristic of the system of planning outlined by Lieut-Colonel Garsia. It starts from the bottom and works upwards, not from the top downwards as in the present system which the Prime Minister defended in his statement on January 22. Free from both planning and executive functions, except in so far as its members participate individually as chairmen of co-ordinating planning committees, the vital responsibility of the War Cabinet he suggests is to give decisions on matters of major importance.

The second essential feature of Colonel Garsia's system is that instead of being based on past experience—what he calls the static method—it takes account of the potentialities of the situation ; not merely the resources available at the moment, but those which might be made available to implement a strategic concept which when the problem is first approached appears to be quite unattainable. This is what he terms dynamic planning, and he quotes a passage from Mr. Churchill's "World Crisis" which illustrates how this concept was present in the Prime Minister's mind more than twenty-five years ago.

This system of what Colonel Garsia terms automatic planning thus originates at the perimeter and not at the head of the organization. Stimulating and utilizing creative thought at all levels, it also

facilitates rapid and decisive elimination of the less promising alternatives as well as the integration of activities while the plan is still nebulous. Responsibility for medium- and long-range planning and the essential staff work involved are delegated to a series of planning committees each of which covers one of the specific fields into which the whole is necessarily subdivided. Use of the proper technique and submission of a reasoned appreciation and plan covering the field for which each committee is responsible enables the co-ordinating Control Planning Committee, the chairman of which would be the secretary of the Committee of Imperial Defence, readily to synthesize a comprehensive plan for the consideration of a War Cabinet relieved of the detailed work and executive duties which might prevent proper attention to major strategy in every field of operation.

This War Cabinet represents the apex of the system. Small and selected for acute analytical minds rather than representing special interests or political parties, and limited to at most three or four in addition to the Prime Minister and the Minister of Defence, under the Prime Minister's leadership, untrammelled by military or other duties, unburdened by quasi-departmental responsibilities, it would supervise and direct all these activities, intervening with decisive authority wherever required. It would, in fact, be in keeping with the Cabinet visualized in the Haldane Committee's report and with the proposals advanced in 1938 by Brigadier Sir Edward Tandy in his lecture before the Royal Society of Arts on "The British Cabinet and its Increasing Burden".

"Planning the War" is a timely and significant contribution to the theory of planning and organization which cannot but make a special appeal to the scientific worker. Moreover, apart from the range and complexity of our existing war effort, our growing relations with the United States impose fresh problems and burdens on our war organization. We cannot expect that partnership to yield its fullest results unless co-operation is effectively organized and planned, and Anglo-French experience prior to 1914 as well as in the opening of the present war well attests the truth of Colonel Garsia's emphasis on the importance of planning in Anglo-American co-operation. Indeed he goes so far as to assert that Anglo-American planning has not yet come into existence.

It is possible to criticize Colonel Garsia's proposals as somewhat too theoretical. They appear, however, in the main to be in harmony with established principles of scientific management, and his emphasis on the importance of sound organization and efficient technique is most timely. There is real danger that the conduct of the war may be endangered and victory delayed by imperfect or inferior staff work in these fields. If we are to make the most effective use of our resources and advantages, our staff work and organization must be equal if not superior to that of our enemy, and there will be widespread agreement with Colonel Garsia's view that our primary requirement to-day is not tanks and guns, but a central organization and technique competent to plan the combined war effort of the British Empire and of the United States.

The main objectives of any reorganization are not in dispute. It should secure the clearest possible definition of strategic purpose in the broadest sense. Planning machinery staffed by specialists must be devised to secure the swift and orderly fulfilment of that purpose, measuring its requirements and marshalling in its service in turn all the resources of man-power and materials available in Great Britain, its allies or partners. Such proposals as those of Colonel Garsia are designed to strengthen, not to weaken, the Government; to avert dangers which a continuance of the present system is likely to precipitate; and to place the Government in a better position to investigate rapidly and constructively the whole conduct of the war and of the allocation of the war output with the one object of organizing that total effort for speedy victory. Above all it is intended to lift from the Prime Minister's shoulders something of the great burden resting upon them and to enable him to assert even more decisively and inspiringly the full vigour of his matchless leadership. That is the real purpose behind the criticism voiced in Colonel Garsia's book, in the debates in the House of Commons, and in many quarters outside, on civil defence, on man-power and on production. The warmth with which Mr. Churchill's subsequent promise of a full and comprehensive statement in a third day's debate on production in public session was welcomed is an eloquent testimony both to the universal regard for his own magnificent leadership, and to the determination that any shortcomings in the organization and management of our war production must be rectified with the utmost dispatch and without regard of persons.

The statement so eagerly awaited was made in the House of Commons on July 29. Mr. Churchill outlined the steps which were taken to prepare a general programme of munitions production at home and in relation to imports, which was approved by the War Cabinet in March last. He then dealt, one by one, with the more specific criticisms which were made in the earlier debate.

It was not to be expected that Mr. Churchill would give facts and figures of production, which would obviously be of the greatest value to the enemy, but he was nevertheless able to dispose of

some misunderstandings. Further, he expressed himself as satisfied with present arrangements—or at least, he declared he was unable to accept the suggestion for a Ministry of Production as likely in present circumstances to give better results. The delays and difficulties which had occurred are now, he said, largely matters of the past, and were due to such factors as the dispersion of factories, the dislocation caused by air raids, enforced changes of diet, and the dilution of skilled industry, and he remarked, "The House must, therefore, be content with my assurance that progress and expansion on a great scale are continuous and remorselessly spurred on".

The debate which followed was wound up by the Minister of Labour, Mr. Bevin. In reply to the criticism that so many skilled workers have been drafted into the Services, he reminded the House that the need for tradesmen in the Services is ten times as great as in any previous war. The Royal Air Force and the Navy have been able to train the great proportion of skilled workers they require, and he expressed the belief that the Army will do the same as its mechanical expansion proceeds. Dealing with industry, however, he agreed that there has been difficulty in building up supervision and management to cope with the sudden development of Governmental activity, and stated that he would like to see management "become a profession".

Looking back now on that debate and its predecessor, on matters of policy of vital import in the conduct of the war—debates which could not take place under a totalitarian regime—surely we can regard them as symbols of the vitality of democracy, and a guarantee that it is capable, when the time comes, of leading the nations to peace and prosperity.

NATURALISM AND SUPERNATURALISM

An Essay on Nature
By Frederick J. E. Woodbridge. Pp. xi+351. (New York: Columbia University Press; London: Oxford University Press, 1940.) 20*s*. net.

THIS is an unusual book, attractively written and well worth reading. It is a direct and general statement of belief such as one seldom gets from a modern philosopher. At this late day a new faith is necessarily suspect. Prof. Woodbridge would probably not claim that his was new, but he could well claim a sane and judicious outlook and a freshness of expression which throws new light on old truths.

Prof. Woodbridge's starting-point is that of naturalism, a candid and, so far as possible, a complete acceptance of the world of fact. This means that Nature is all that can be discovered by the help of experience. Nature "is the field of knowledge and as that field she is pre-eminently the familiar visible world. The problems of knowledge are all problems of formulating her coherences" (p. 331). On this view it is a profound mistake to divide the natural world into two parts, one that is seen but not understood, another that is understood by means of scientific theory but not visible. A consequence of the stress laid on the unity of Nature is the conclusion that the relations of the sciences have been generally misconceived. "Nature, not the wit of man, gives to knowledge its integral character. This suggests a science of nature which is neither physics nor chemistry and the like nor the social sciences and their like and which is, in a somewhat Hegelian way, a special science because restricted to what is not specific, but general. Had the history of the sciences been kind in its preference for Greek words this special science might well have been called 'physics' and all others summed up under 'metaphysics', subdivided in terms of specific subject matter" (pp. 58–59). If Prof. Woodbridge is right, this general science scarcely exists as yet.

Granted a candid recognition of facts, Prof. Woodbridge argues that one among those to be recognized is the fact that men pursue other ends besides knowledge, ends that may be summed up as 'happiness'. For knowledge Nature is primary, but for happiness, secondary. "The important fact is that the pursuit of happiness leads to the question whether that pursuit is worth while. That is the great question that has haunted mankind for ages. In a way it is an odd question. Nobody ever seems wholly content to take the positive fact that happiness is pursued as an answer" (p. 334). If the pursuit is to be justified, it is justified by faith in (not knowledge of) the 'supernatural'. Prof. Woodbridge prefers the term 'supernatural' to the more popular term 'ideal', although, as he says, it is commonly disliked and supposed to imply superstition. But superstition is not faith; it is the attempt to deal with the supernatural by blackmail or bribery. The distinction is that between Job, who kept faith though he were to be slain, and Saul, who consulted the witch of Endor. This is perhaps the main conclusion of the book, that supernaturalism is not the antithesis of naturalism but its necessary complement. On one hand, claims to knowledge

are invalid unless they follow from an acceptance of the realm of facts; on the other, human interests are unsatisfied, even the interest in knowledge, without the realization that the realm of facts is in itself incomplete. In other words, without faith in something else, for which Nature is secondary, there is no motive for trying to understand Nature.

There is one criticism to be made, concerned rather with the method of statement than with any substantial point. The author speaks of Nature as being pre-eminently the visible world and this is to a large extent true. Such a statement, however, obscures the fact that the physical sciences could be studied by blind men possessing the other senses, but not by beings possessing sight only. Measurement, as Berkeley pointed out long ago, is of tangible objects even though referred to visible objects and expressed in visual terms. Newton's laws of motion describe the operation of tangible things. If they are applied to the stars, it is because these visible objects are treated as though they were tangible. A. D. Ritchie.

PHYSICS OF OIL PROSPECTING

Geophysical Prospecting for Oil
By L. L. Nettleton. Pp. xi+444. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s*.

In the last few months a number of very welcome books have been published in the United States on the subject of geophysical prospecting. Of these, the present work fulfils a very useful purpose, as it is written mainly for the layman, that is the petroleum geologist and the petroleum engineer. These, as a rule, do not participate actively in this branch of oil prospecting; nevertheless they should be in a position to appreciate the possibilities and limitations of the various methods which can be employed for this purpose, and also they should be able to understand the implications of any geophysical survey. In such a subject as geophysical prospecting, in which the technique is advancing rapidly, there are obvious difficulties in the way of the layman who wishes to keep in touch with the latest developments. Nettleton's book, giving a reliable and co-ordinated picture of the present state of geophysical prospecting in relation to oil, should do much to remove these difficulties and to form a background against which future developments can be assessed.

In common with most books on the subject, it is divided into four sections, three of these being devoted to the most important methods of oil prospecting, namely the gravitational, the magnetic and the seismic methods respectively, and these occupy nearly 90 per cent of the whole. The remaining section, devoted to the electrical applications (including electrical coring) and to miscellaneous methods, is contained in less than fifty pages and is by far the weakest part of the work. The book is generously illustrated, and for those who wish for further detail on the main points, each section is furnished with a brief bibliography of the more important papers on the subject.

From the author's preface, it appears that the book had three objects. The first, and most important, is to present a reliable picture of the principles and practice of geophysical prospecting for oil, primarily for the layman. At the same time, as a second object it is tentatively suggested that much of the material will serve as a useful reference for the specialist. Finally, and really part of the first aim, the writer hopes to give the student an appreciation of geophysical maps, the immediate product of any survey.

On the whole, the first of these objects has been attained reasonably well, and in certain chapters extremely well. Thus, the section dealing with direct gravity-measuring instruments is an excellent example of the standard suitable for the beginner, particularly the geologist. It is profusely illustrated with twenty figures in less than thirty pages, the diagrams themselves being, in many cases, almost self-explanatory. These, supplemented by short paragraphs in the text, give a clear, if somewhat simplified, picture of the modern instrument. On the other hand, certain parts are treated in a more mathematical manner, for example, the theory of the torsion balance, the vertical force variometer and many of the factors involved in interpretation. Although the treatment is elementary, it is likely to prove heavy for the non-mathematically trained geologist, and is more suitable for the physicist. The second object is obviously incompatible with the first, for those aspects which are likely to appeal to the beginner cannot contain the detail to which the specialist will have occasion to refer. Certain features of use to the professional are certainly included, such as the average physical properties of rocks, gravity tables, charts and tables for terrain corrections, etc., but the list is far from being comprehensive. Formulæ for the computation of effects are very sparse, referring only to the simplest shapes, and these are used mainly to illustrate certain factors involved in the interpretation of results. The most serious criticism which can be made is the lack of examples of actual geophysical surveys. In the gravitational and magnetic sections, not a single

geophysical map is given, while in the seismic section only two or three examples appear.

Nevertheless, the petroleum technologist who is interested should derive much benefit from the book, for the mathematical treatments are usually preceded by a section devoted on the physical principles involved, and the physicist should find it an easy introduction to the subject. Both, however, would find it necessary to supplement the volume with practical examples before the true purpose of the book was achieved.

J. McG. Bruckshaw.

MODERN SURVEYING

(1) Plane and Geodetic Surveying for Engineers
By the late Prof. David Clark. (Text Books of Civil Engineering.) Vol. 1: Plane Surveying. Third Edition, revised and enlarged by James Clendinning. Pp. xvi+620. (London: Constable & Co., Ltd., 1940.) 27*s*. 6*d*. net.

(2) Engineering Surveys
By Harry Rubey, Prof. George Edward Lommel, and Prof. Marion Wesley Todd. (Engineering Science Series.) Revised edition. Pp. xv+322+142. (New York: The Macmillan Company, 1940.) 15*s*. net.

(3) Route Surveying
By Prof. George Wellington Pickels and Prof. Carroll Carson Wiley. Second edition. Pp. xv+427. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 21*s*. net.

(4) Introduction to Mine Surveying
By W. W. Staley. Pp. vii+276. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1940.) 21*s*. 6*d*. net.

IN a general text on surveying, as is pointed out by the author of one of these books, there is little room for originality except in treatment. Regarded as a branch of mathematics or as a conventional system of making, recording and plotting earth measurements, the subject is one which demands strict adherence to well-established rules. The improvements in instruments made possible by better designs and by increasing precision of manufacture whereby the degree of accuracy has risen from 1 in 5,000 to 1 in 30,000, cause changes to take place such as the substitution, in certain cases, of traversing for the more laborious method of triangulation.

(1) As an example of a text-book which has been maintained in close relation to modern tendencies, Clark's "Plane and Geodetic Surveying" may be cited. The third edition of vol. 1 deals with practically all the knowledge required of the average civil engineer and is distinguished by the clear terms in which instruments and methods have been described and explained. To bring it into line with recent developments the editor has added a chapter on linear measurements and has extended the original section on traversing so that it is now represented by one dealing with field work and another with office computations. Other important additions include instruction on the theory of errors, on road transition curves and on the important aid to hydrographic surveying provided by the echo-sounding apparatus.

(2) "Engineering Surveys" deals in a more concise but equally clear way with the same general subject from the point of view of the present-day engineer. In the revised edition, the excellent Macmillan Mathematical Tables have been retained and one giving the average air correction for barometric levelling temperature has been added. Otherwise, changes made in the text are matters of detail introduced to ensure a practical up-to-date presentation of the subject eminently suitable either for instruction or for casual reference.

(3) "Route Surveying" is more limited in scope and deals with the essentials of railroad, highway and other route surveys as required for transmission lines, pipe lines, canals, drainage, etc. The major changes introduced include extensive new matter on circular curves and spirals and on the string-lining method as applied to the re-alignment of existing railroad curves. Although the spiral is usually regarded as complex and difficult, the presentation of it here from the point of view of change of curvature makes it appear but slightly more difficult than a simple curve, and the treatment is probably as complete as any so far available.

(4) In "Mine Surveying", another branch of the subject is presented. It is a new book devised to make good the deficiency of works on the subject and is largely based on a questionnaire sent to prominent companies in North America engaged in gold, silver, copper, lead and zinc mining. The author, from his own experience, has supplemented and organized the important information thus obtained as to present-day practice. As the reader is assumed to have a basic knowledge of plane surveying, the text is wholly devoted to the specialized methods and instruments devised for use in mines, and represents well-authenticated practice of the present day.

CHARLES CHREE AND HIS WORK ON GEOMAGNETISM*

By Prof. S. Chapman, F.R.S.

CHARLES CHREE, a son of the manse, an Aberdonian scholar brilliant in classics as well as in science, distinguished later at Cambridge as a mathematical expert on the theory of elasticity, in 1893 took up new and very different labours as superintendent of the magnetic and meteorological observatory at Kew. When he retired in 1925 he was president of both the international organizations concerned with geomagnetism.

British Contributions to Geomagnetism

In the earth sciences, most of all, international co-operation is a necessity for progress; yet each nation may feel pride in its own contributions to the common stock. In geomagnetism Britain has a long and distinguished record. Queen Elizabeth's hydrographer Robert Norman was the first to measure the magnetic dip (1576); her physician William Gilbert wrote "de Magnete" (1600), the first modern scientific treatise. Gellibrand, Gresham professor, discovered the secular magnetic variation (1634); Halley made the first scientific voyages (1698–1700) to measure the magnetic declination, and also constructed the first magnetic chart (1701). Graham, the London instrument maker, discovered the transient magnetic variations (1724).

In the nineteenth century Sabine fostered the British Colonial magnetic observatories, discovered the 11-year cycle in geomagnetism, and like Broun of Trevandrum, made notable studies of the lunar geomagnetic tide. Balfour Stewart was the first to realize the existence of the ionosphere as the primary source, through dynamo action, of the daily magnetic variations (1882). Schuster applied Gauss's method of spherical harmonic analysis to these variations (1889), and developed Stewart's dynamo theory (1908). Maunder made brilliant studies on the connexions between the sun and magnetic storms (1904–16).

Chree and his Contemporaries

Chree, contemporary with Schuster and Maunder, was in this distinguished succession, and his name will endure in the history of geomagnetism. Other notable contemporaries were Bauer, the initiator and first director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, and Schmidt, van Bemmelen and Moos, the directors of the magnetic observatories at Potsdam, Batavia and Bombay; like Chree, they were not content with maintaining a high standard of accuracy in the magnetic measurements under their charge; they had also the energy, ability and inward impulse to undertake the scientific discussion of their records.

Chree maintained the reputation of Kew as a magnetic centre of the first rank; he standardized magnetic instruments, trained many young men to use them, notably on polar and other magnetic expeditions, and gave immense time and effort to the discussion not only of the Kew data, but also of records obtained by four Antarctic expeditions. He brought to his work, besides untiring industry and devotion, a meticulous attention to detail, and a clear, critical and scrupulously exact mind.

Geomagnetism has need of men of widely different gifts: of the organizer and administrator; of the man of affairs, who can influence Governments or private benefactors to provide resources for the science; of the navigator and explorer; of the instrument designer and maker; of the patient, skilled and resourceful observer, often far from social and technical centres; of the faithful computer, zealous for detailed accuracy; of the investigator, theorist and writer.

Bauer was a man of enthusiasm and energy, who took wide views and realized great projects; but his eagerness to reach conclusions, where sometimes judgment was better deferred, met a useful corrective in Chree's critical detachment, which later administered some cooling draughts to my own youthful optimism. Schuster, though perhaps not Chree's equal as a mathematician, nor with a tithe of his detailed knowledge of geomagnetism, could make brilliant sorties into the subject, leading to striking theoretical conclusions; by labours trifling compared with Chree's, he lifted some parts of the subject to a new level. Maunder had a daily familiarity with the sun's aspect, as well as with the Greenwich magnetic records; this enabled him to perceive certain remarkable associations between the sun and magnetic storms; his work stimulated Chree to some of his finest achievements.

Whereas Schuster, Maunder and Bauer were ready to make hypotheses, Chree held that a theory was not necessary as a guide to research, and he refrained from speculation; nevertheless his work was greatly influenced by the speculations of Maunder and Arrhenius on the magnetic effects of streams of particles emitted from the sun.

* From the first Charles Chree Address to the Physical Society, delivered on July 25. The latter part of the address, referring to the future of world magnetic surveying, is not included in this summary.

DOES GEOMAGNETIC DISTURBANCE LAG BEHIND SOLAR ACTIVITY?

Chree showed that when there were many or large spots on the sun, days of geomagnetic calm were rarer than on days of no or few spots; but the difference was very slight. He concluded that geomagnetic disturbance could not depend directly in any large degree on the simultaneous area of spots on the sun, but that his results might easily be reconciled with Arrhenius's view that geomagnetic disturbance lagged two or three days after the solar cause, because of the time taken by the solar particles to travel from the sun to the earth.

To study this possibility, Chree in 1908 devised a new method of great value and power, which I have called the *method of superposed epochs*. He examined how, on the average, the sunspot area varied during a number of intervals, each of 4 days, and each ending with a day of selected geomagnetic character (either calm or disturbed): thus in the averaging, the epochs of these selected days were superposed. Later he and his followers considered intervals of greater length, extending after as well as before the selected superposed days; he

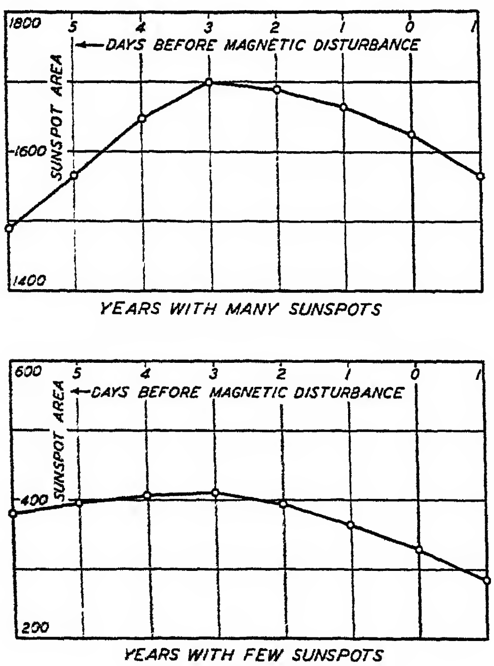


Fig. 1*.

AVERAGE SUNSPOT AREAS, EXPRESSED IN MILLIONTHS OF THE SUN'S DISK, FROM 6 DAYS BEFORE UNTIL 1 DAY AFTER DAYS (EPOCH 0) SELECTED AS MAGNETICALLY DISTURBED.

Above: averages for 250 sets of days in years with many sunspots. Below: averages for 116 sets of days in years with few sunspots. After J. M. Stagg.

* This, and the other illustrations, are from "Geomagnetism", by Prof. S. Chapman and Dr. J. Bartels (Oxford University Press, 1940).

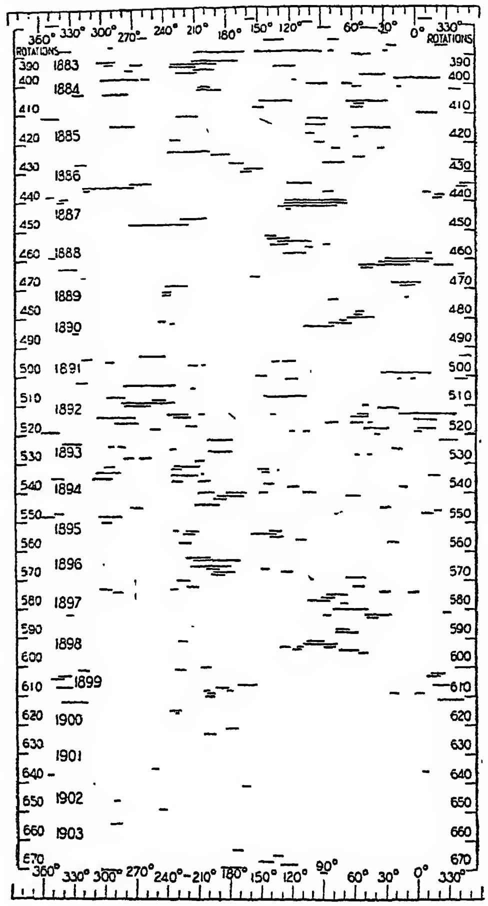


Fig. 2.

DISTRIBUTION OF MAGNETIC DISTURBANCES, 1882–1903, ACCORDING TO THE HELIOGRAPHIC LONGITUDE OF THE CENTRE OF THE SUN'S DISK AT THE TIME OF THEIR COMMENCEMENT. After E. W. Maunder.

also considered in the same way the average variation of the geomagnetic activity before and after days of selected sunspot character.

In the hands of Maurain, and later of Stagg, using much more material than Chree, results were thus obtained which leave little room for doubt that on the average, on days of notable geomagnetic disturbance, the sunspottedness is declining from a maximum value attained two or three days earlier (Fig. 1); but the sunspot peak is shallow, and may be obscured by accidental circumstances if the material is too scanty to average these out. This is the less surprising because sunspots are at least not the sole cause of magnetic disturbance, which sometimes occurs during intervals of many days free from sunspots.

THE 27-DAY RECURRENCE TENDENCY

Chree's method was thus successful in elucidating an important interrelationship between solar and geomagnetic data. Chree also made a still more

beautiful and successful application of his method, to test a time relationship appearing in the geomagnetic data by themselves. This is a tendency for geomagnetic conditions of exceptional calm or exceptional disturbance to recur, generally with diminished intensity, after about 27 days; it is therefore called the 27-day recurrence tendency.

This had been recognized by Broun (1858) and by many others after him, who had directed attention to a 'period' of 27 or 28 days in magnetic and auroral phenomena. But its nature was not understood, and even its existence was often doubted or overlooked, until Maunder rediscovered it and demonstrated its real character in 1904. Some of his predecessors had thought it might be connected with the lunar month; but Maunder, deeply imbued with a knowledge of the succession of both solar and magnetic phenomena, was quite clear as to its solar origin. He regarded the sun as intermittently ejecting limited streams of corpuscles which, like water from a fire-hose, may sweep the earth at successive rotations of the sun, if the emission is sufficiently prolonged. His presentation of his discovery was made with this idea in view, and from the point of view of the solar physicist.

His demonstration was graphical, by means of a diagram (Fig. 2) in which the solar longitude of the centre of the sun's disk (as viewed from the earth) is measured along a succession of horizontal lines drawn at equal vertical intervals; each line represents one rotation, occupying 27·3 days, of a certain standard meridian on the sun. If during any such rotation one or more geomagnetic storms occurred, Maunder marked the part or parts of the horizontal line for that rotation, between the solar longitudes corresponding to the beginning and end of the storm; the remaining part of this and other lines, not corresponding to the occurrence of a storm, was obliterated (or rather not drawn). The diagram shows that many of these storm lines fall nearly on the same vertical, corresponding to nearly the same solar longitude, and indicating a recurrence after an interval of one or more solar rotation periods of 27·3 days.

Maunder's diagram, however, has no necessary connexion with the sun; it forms what I have called a *time-pattern*, in which successive horizontal lines represent merely successive intervals of 27·3 days. Maunder adopted the 27·3 day interval because it is the mean rotation period of sunspots; but he recognized that if a sequence of storms occurred at a slightly different interval, this would be clearly shown by a slight displacement of their successive 'lines' to the right or to the left. In his diagram the sequences of storm lines are rarely so clear cut as to show whether the usual interval is 27·3 days, or half a day more or less than this. The identification of the mean recurrence interval with the solar rotation period is an independent step which, though highly probable, is a speculation rather than, like the recurrence interval itself, an established fact.

CHREE'S 27-DAY PULSE DIAGRAM

Chree applied his superposed epoch method to this question, using as the selected epochs days of

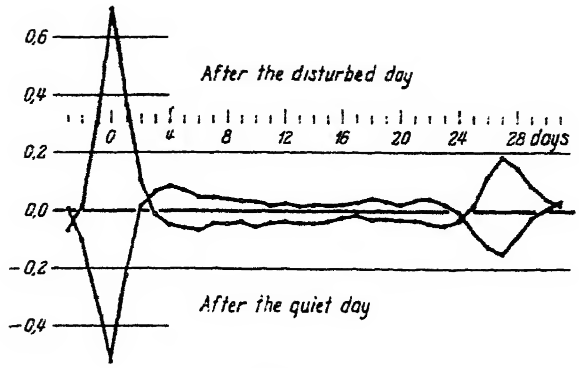


Fig. 3*a*.

AVERAGE CHANGE IN THE DAILY MAGNETIC CHARACTER-FIGURES, INDICATED BY THE DEVIATIONS FROM THE MEAN, FROM FOUR DAYS BEFORE UNTIL 31 DAYS AFTER A SET OF DISTURBED OR A SET OF QUIET DAYS, 1906–24. After Chree and Stagg.

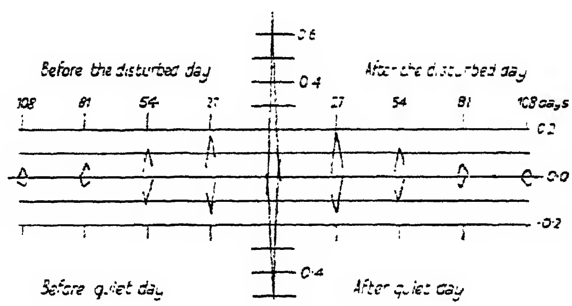


Fig. 3*b*.

AVERAGE CHANGE IN THE DAILY MAGNETIC CHARACTER-FIGURES, INDICATED BY THE DEVIATIONS FROM THE MEAN, FOR GROUPS OF DAYS AROUND A SET OF DISTURBED OR A SET OF QUIET DAYS (CENTRE), AND AROUND EPOCHS 1, 2, 3, 4 SOLAR ROTATIONS (OF 27 DAYS EACH) BEFORE AND AFTER. After Chree and Stagg.

either disturbed or quiet geomagnetic conditions. The daily data averaged for these days, and for the preceding and following days, were purely magnetic, namely the character figures internationally assigned as an index of each Greenwich day's geomagnetic activity. Some of his results are illustrated in Fig. 3 (*a*, *b*); the upper and lower parts of Fig. 3*a* refer respectively to the averages when the selected epochs are disturbed or calm. There are naturally peaks (positive or negative) for the selected days; there are also peaks 27 days

afterwards. This demonstrates the recurrence tendency and gives an indication of the recurrence interval, while involving absolutely no preconceived notion as to its length or significance.

Later Chree showed that there are corresponding peaks, of diminishing height (or depth) at about 54 and 81 days after the selected disturbed (or quiet) days, and also at similar intervals before them (Fig. 3*b*, where the averages for the days not near the peaks are not shown).

In my opinion this beautiful and brilliant application of his method is Chree's highest achievement and best gift to geomagnetic science ; his fame will always be linked with his pulse diagrams. This graphic product of his genius fitly finds a place on the Chree Medal.

Within the last two years Chree's method of superposed epochs has found useful applications to the time relationships of cosmic ray data, both as regards interrelationships with geomagnetic activity, and as regards the 27-day recurrence tendency in cosmic ray measures alone.

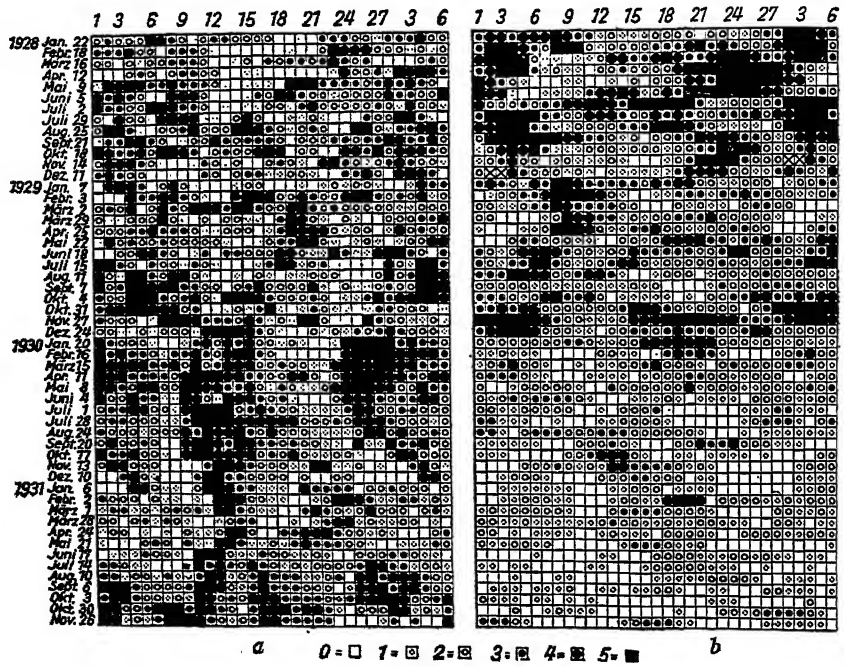


Fig. 4.

TIME-PATTERNS, FOR SUCCESSIVE ROWS OF 27 DAYS, ILLUSTRATING THE 27-DAY RECURRENCE TENDENCY FOR THE DAILY MAGNETIC ACTIVITY (LEFT, *a*) AND THE DAILY SUNSPOTTEDNESS (RIGHT, *b*). THE DATE FOR THE FIRST DAY IN EACH ROW IS INDICATED AT THE LEFT. After J. Bartels.

TIME-PATTERNS

Chree examined in great detail the significance of the recurrence pulses in his diagrams, to see, for example, whether they were due to the recurrence of a few notable days of the selected character, or merely to the occurrence of that character to a more moderate degree in a large proportion of days around the recurrence epoch.

In the course of such detailed investigation undertaken by Chree later, in conjunction with Stagg, differences were found between the pulse recurrences in 1920–21 and 1922–23. To examine these in more detail, they constructed two 27-day time-patterns, on which the international daily magnetic character figures were arranged in successive 27-day rows ; these figures were entered only for specially quiet or specially disturbed days, so that most of the 'pattern' was blank (as in Fig. 2); it showed the recurrence tendency in the same manner as in Fig. 2, by the grouping of disturbed or quiet days along the same verticals.

This diagram by Chree and Stagg forms a transitional stage between Maunder's diagram and later time-patterns constructed by Bartels. Maunder's diagram, despite its solar 'dress', was a true time-pattern, each row representing 27·3 days ; it showed the occurrence of outstanding magnetic disturbance, beginning and ending at different Greenwich times, and of varying duration ; the greater portion of the diagram was empty. The Chree–Stagg time-pattern was also mainly empty ; it showed specially quiet as well as specially disturbed periods ; but these were taken in units of the Greenwich day, and the horizontal range of

the diagram is 27 days (this does not prevent the diagram from showing a recurrence interval differing from 27 days; recurrences with a different interval would be shown by a slope of the sequences in successive rows).

Bartels by successive stages brought the 27-day time-pattern to perfection (1) by including all days, and (2) by indicating their magnetic character by a greater or less proportion of black (representing magnetic activity) in the square corresponding to each day. The result is shown in Fig. 4 (left); such a diagram represents an extraordinary concentration of knowledge, derived from magnetic observatories all over the world, over a period of nearly four years. The recurrence tendency is clearly shown by the 'columnar' distribution of the blackest and lightest parts of the diagram, though at least one recurrence sequence (near the end of 1930) is notably sloping, implying a recurrence interval of more than 28 days.

Bartels also applied his method to construct a time-pattern of solar activity, based on the daily *sunspot* number, as shown in Fig. 4 (right). The comparative study of the two diagrams for the same period is of great interest. The decline from the maximum (1928) of the sunspot cycle is much more strongly manifested by sunspots than by magnetic disturbance, and even in periods when both the sun and magnetic disturbance were active, their time-patterns are often very different. This shows that sunspots are often not a good index of the agencies on the sun that cause geomagnetic disturbance.

I feel confident that not only the method of superposed epochs, but also the study of time-patterns, has much still to contribute to geophysics and cosmical physics.

THE STUDY OF ENERGY-LEVELS IN BIOCHEMISTRY*

By Prof. A. Szent-Györgyi,
University of Szeged, Hungary

THE atom consists of a nucleus surrounded by a system of electrons. By sharing one or more electrons, atoms can join to form molecules. In such a molecule, as a rule, every electron belongs to one or two atoms. This is our idea of a single small molecule, and this picture has hitherto unconsciously governed our thinking in biochemistry.

The study of crystals and metals, however, has revealed the existence of a different state of matter. If a great number of atoms be arranged with regularity in close proximity, as for example, in a crystal lattice, the terms of the single valency electrons may fuse into common bands. The electrons in this band cease to belong to one or two atoms only, and belong to the whole system.

These bands or energy-levels are separated from possibly higher levels by forbidden zones. Under ordinary conditions all electrons are within the lowest band. If this lowest band contains the maximum number of electrons ($2n$, if the number of atoms is n), as is the case with insulators, the electrons will be unable to transport energy. If, however, one of these electrons is raised by the absorption of energy to a higher level, and comes to be in what we call an excited state, where it will move and transport its energy freely, it will be impossible to say which is the atom to which the excited electron belongs, and the whole system can be looked upon as activated. By falling back to the lower level the electron will give off its excess energy and perform work in a place more or less distant from that of the absorption of energy. This is the case with certain phosphors, as has been shown recently by N. Riehl[1]. Here, as for example in zinc sulphide, the electron, raised to a higher level by a collision with an α-particle, can travel relatively long distances and will fall back to a lower level, giving up its energy where it meets a copper atom present as an impurity. Thus the absorption and emission of energy will proceed independently at different places.

The problem is whether this state of matter, that is, common energy-levels, exists also in living systems. If it does, it cannot fail to influence profoundly our biological thinking and open new approaches to research and understanding. Protein molecules are systems built up of a great number of atoms, closely packed with great regularity. So theoretically the possibility exists that within these molecules analogous conditions prevail to those in crystals.

The first indication of the existence of such common energy-levels was given by the study of photosynthesis. Emerson and Arnold[2] found that 2,500 chlorophyll molecules form one functional unit. Warburg and Negelein[3] showed that four quanta are necessary for the reduction of one

* Substance of the Korányi Memorial Lecture, given in Budapest on March 21, 1941.

carbon dioxide molecule. There are observations to indicate that these four quanta must reach the carbon dioxide molecule simultaneously. Gaffron and Wohl[4] calculated how many chlorophyll molecules must interact to absorb four quanta simultaneously at the weakest optimal illumination. Their calculation showed that only one thousand molecules are capable of doing this. These observations indicate that the electrons, raised to a higher energy-level by the absorbed light, can move and transport their energy freely through the system of chlorophyll molecules.

Kubowitz and Haas[5] have measured the inactivation spectrum of urease, and P. Jordan[6] has pointed out that their results are in agreement with the idea that common energy-levels exist within this protein molecule. At present, K. Laki and M. Gerendás are engaged in my laboratory in the study of the inactivation spectrum of fumarase, crystallized by Laki. Their results also indicate that the energy absorbed may leave the place of its absorption and cause a break of links at a different place, thus travelling to some distance through the molecule. (If common energy-levels are present in native protein molecules, this cannot fail to contribute to the stability of the molecule and influence its immunological behaviour.)

The more interesting question, however, is not whether common energy-levels exist within one molecule; but whether protein molecules can join into more extended systems with common energy-levels. It would be difficult to picture such a continuum built up of globular protein molecules, and protein molecules have hitherto, with rare exceptions, been found to be globular. However, last year Banga and I[7] found that the proteins building up the solid structure of the cell are fibrous, and that these fibrous molecules, as shown by their strong thixotropy, are interconnected by intermolecular forces. Chloroplasts also contain fibrous proteins.

This finding allows us to suppose tentatively that a greater number of molecules may join to form such energy continua, along which energy, namely, excited electrons, may travel a certain distance. The study of gene mutation, induced by X-rays and ultra-violet light, also indicates such a possibility.

It cannot be expected that any single observation will definitely solve this problem. Only the accumulation of a great mass of data will answer these questions. But even at this early stage we are justified in reconsidering the biological problems in the light of these possibilities.

My own biochemical research of two decades has yielded one or another insignificant result—the isolation of this or that—but whenever I was faced with a fundamental problem, I failed. When these problems are reconsidered in the light of common energy-levels an easy explanation offers itself. I will enumerate a few of these problems, starting with one which arose lately in collaboration with Banga[7].

The contractile element in muscle is myosine, a protein built up of fibrous molecules. These molecules are arranged in small, primitive bundles. A great number of such primitive bundles forms one microscopic fibril. The energy of muscular contraction is derived from the splitting of adenosine triphosphate. The adenosinetriphosphatase activity is bound up with myosine, but our measurements indicate that only a very small fraction of myosine molecules can be endowed with such activity. The problem is, how the energy liberated by a molecule can be communicated to a great number of similar molecules. The common energy-levels give an easy answer.

Another problem that troubled me for many years was why the enzymes involved in oxidation and fermentation can be separated so sharply into soluble and insoluble ones. The enzymes involved in lactic fermentation of muscle are soluble, while the enzymes involved in oxidation are insoluble, that is, bound to the insoluble fibrous proteins of the cell. This difference can be explained if we suppose that the latter are part of a system with common energy-levels. In lactic fermentation no such common levels are necessary, for the single enzymes do not interact but react in series with soluble molecules.

Still another problem, closely connected with the former, is how the enzymes of oxidation interact. In part of the oxidation system electrons wander directly from enzyme to enzyme. The enzymes, being insoluble, have no free molecular motion and must be arranged so that their small reactive groups are at atomic distances. It is possible to arrange two large protein molecules in such a way, but it is geometrically impossible so to arrange a whole series. Even if we could devise such an arrangement, it would still be incomprehensible how the energy liberated by the passing of an electron from one substance to the other, for example, from one iron atom to the other, could do anything useful. All this can be understood if we suppose that the single catalysts are connected with different, distinct energy-levels and that the electrons do not pass directly from one substance to the other but travel within the corresponding energy band, and can fall to a lower level and give off energy only at a place where they can do work (for example, a synthesis) analogous to the zinc sulphide phosphors of Riehl. If the cell and with it the energy-levels are disturbed in some way, we can expect the electrons to fall freely to lower levels at any place. This might explain why cata-

bolic processes prevail over anabolic ones in damaged tissues (and cancer ?), why certain oxidations (catecholoxidase) are activated by damage, why chloroplasts do not build up carbohydrates, and why viruses do not multiply outside the cell.

One of my difficulties with protein chemistry was that I could not imagine how such a protein molecule can 'live'. Even the most involved protein structural formula looks 'stupid', if I may say so. If the atomic structure is only the backbone underlying the common energy-levels, the thing becomes more likely. It is equally difficult to understand the great biological activity of certain molecules. R. Kuhn, F. Moewus and D. Jerchel[8]. have shown lately that one single crocin molecule is capable of inducing a sexual change in a whole alga. If the cell forms an energy continuum, any substance, approaching at any point, can upset the whole system, making, so to say, a hole in the continuum.

Then we do not know what a 'cell' really means, or why the kidney, for example, is subdivided into such units. Possibly the cell wall is the border line of the common energy-levels.

Biochemistry is, at present, in a peculiar state. By means of our active substances we can produce the most astounding biological reactions, but we fail wherever a real explanation of molecular mechanisms is wanted. It looks as if some basic fact about life were still missing, without which any real understanding is impossible. It may be that the knowledge of common energy-levels will start a new period in biochemistry, taking this science into the realm of quantum mechanics.

[1] Riehl, N., *Naturwiss.*, **28**, 601 (1940).

[2] Emerson, R., and Arnold, W., *J. Gen. Physiol.*, **16**, 191 (1930).

[3] Warburg, O., and Negelein, E., *Naturwiss.*, **13**, 985 (1925).

[4] Gaffron, H., and Wohl, K., *Naturwiss.*, **24**, 81 (1936).

[5] Kubowitz, F., and Haas, E., *Biochem. Z.*, **257**, 337 (1933).

[6] Jordan, P., *Naturwiss.*, **42**, 693 (1938).

[7] Banga, J., and Szent-Györgyi, *Science*, **92**, 514 (1940); *Enzymologia*, **9**, 111 (1940).

[8] Kuhn, R., Moewus, F., and Jerchel, D., *Ber. Chem. Ges.*, **71**, 1541 (1938).

OBITUARIES

Sir David Wilson Barker

SIR DAVID WILSON BARKER, whose death occurred on June 15, was born on October 1, 1858. He was educated in the training-ship H.M.S. *Worcester*, and on leaving in 1873 joined the Blackwall Line and served in sailing-ships of that company for eight years, rising to the rank of chief mate of the *Superb*. Afterwards he joined the Silvertown Telegraph Works Co., and in 1885 was given command of the cable ship *Dacia*, an appointment which he held with that of cable engineer until August 1892.

Captain Barker will best be remembered as captain superintendent of the training-ship H.M.S. *Worcester*, an appointment which he held with much distinction during 1892–1919.

He was a born seaman and natural scientist—he took a very great interest in meteorology and natural history and made a particular study of sea birds and their habits; he was also an enthusiastic photographer and took up colour photography with some success in its early stages of development.

He was much sought after by various societies and associations on whose committees he served; of these may be mentioned the Royal Geographical Society, the Royal Meteorological Society, of which he was president during 1903–5, and the Challenger Society; he was vice-president International Pollok Prize Committee for Saving Life at Sea, 1901, chairman of British Section of Marseilles International Fisheries Exhibition, 1906. In spite of his busy life he also found time to contribute many papers to the Press on subjects connected with the sea. His numerous activities and the services rendered the country in the training of young officers brought its reward when on retiring from official life in 1919 he received the honour of knighthood.

After his retirement, Sir David continued his active life, lecturing and writing and interesting himself in anything connected with the sea; he was one of the vice-presidents of the London Scout Association and at one time commissioner of Sea Scouts for London. In 1922 he undertook a special mission to Gambia at the request of the Colonial Office to advise on the reorganization of the Gambia Marine.

Many old Worcesters and others will regret his passing and will remember with gratitude his helpful advice and kindly interest—nothing gave him greater pleasure than to meet his "old boys".

Mr. H. W. Hilliar, C.B.E.

THE death occurred at Eltham on July 15 of Mr. H. W. Hilliar, formerly a superintending examiner in the Patent Office. After serving for a time as a chemist at the British Uralite Works near Gravesend, Hilliar (who had taken his B.Sc. at London) entered the Patent Office as an assistant examiner in 1906 at a time when the staff had been greatly enlarged to deal with the newly instituted search for novelty of inventions. By 1914 his work had already received special recognition, and when the War broke out he was lent to the Research Department of the Admiralty, where he conducted important investigations upon the effect of depth charges, for which he was made C.B.E.

Returning to the Patent Office he secured rapid promotion to the grades of examiner (1921), senior examiner (1925) and superintending examiner (1932). During most of his service at the Patent Office he was engaged upon the examination of inventions relating to automatic telephones, of which he had a profound knowledge. He compiled the material for a book on this subject, but his health prevented its completion. He also made a deep study of the case law relating to patents, and in his later years as a hearing officer his judgment both on scientific and legal matters was trusted by all.

Hilliar's first-rate analytical power was combined with great patience, courtesy and charm of character, which endeared him to all who knew him, and his retirement in 1937 owing to ill-health was a great loss to the Patent Office.

We regret to announce the following deaths:

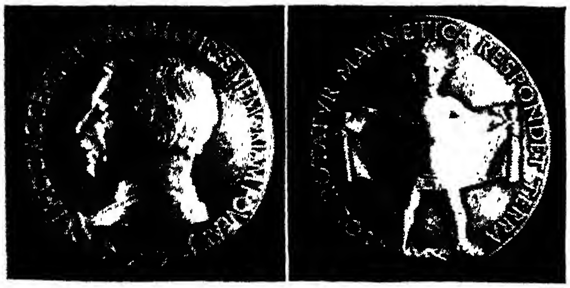
Prof. J. C. Philip, F.R.S., emeritus professor of physical chemistry in the Imperial College of Science and Technology, on August 6, aged sixty-eight.

Prof. A. J. Clark, F.R.S., professor of materia medica in the University of Edinburgh, on July 30, aged fifty-five.

NEWS AND VIEWS

Charles Chree Medal and Address

At the science meeting of the Physical Society on July 25, the Charles Chree Medal and Prize were presented to Prof. Sydney Chapman, who delivered an address, part of which appears on p. 153 of this issue. The circumstances of the foundation were described in the issue of Nature of March 1, p. 261. The Medal, which is a particularly beautiful example of the medallist's art, is the work of the distinguished artist, Mrs. Mary Gillick, and the reverse design most fittingly summarizes and symbolizes the outstanding work of Chree. The Society is to be congratulated on its first award of the Medal.



The Charles Chree Medal

Prof. Chapman's work for the advancement of the science of geomagnetism is both long and distinguished. It began so far back as 1911, when it fell to his lot, on his appointment as chief assistant at the Royal Observatory, Greenwich, to design new instruments and buildings for magnetic observations. His work on the solar and lunar diurnal variation and on magnetic storms is outstanding, and his investigations of the lunar variation have involved the ordering and discussion of an immense mass of material such as would daunt the courage of all save the boldest and most clear-headed investigator. His analysis, which has been made by the aid of methods largely devised by himself, has resulted in a clear formulation of the effect of the sun and moon on terrestrial magnetism, and in a notable increase in our knowledge of the mechanism of the effect. His work on magnetic storms, which has not yet approached a final phase, is of the first importance. The analysis, which has involved very complicated mathematical theory, has resulted in a theory of storms depending on the emission of particles from the sun.

Great Britain and the U.S.S.R.

In reply to the cable of greetings sent by the Royal Society to the Academy of Sciences of the U.S.S.R. (see Nature, August 2, p. 135), Dr. Otto Schmidt, vice-president of the Academy, has sent the following message: "The Academy of Sciences of the U.S.S.R. sends its warmest greetings to the Royal Society, London. Soviet scientists express feelings of deep admiration and friendship to British colleagues who in war conditions pursue courageously their research work, obtaining world achievements in various fields of science and thus successfully opposing the aim of Fascism to destroy all culture. In the struggle for the happy future of humanity, standing hand in hand against the common foe, men of science of Great Britain and the Soviet Union will contribute with all their forces to the triumph of liberty, culture and science over Hitlerite tyranny and obscurantism."

W. H. Hudson Centenary

The centenary of the birth of the British naturalist, W. H. Hudson, occurred on August 4. Hudson was born at Quilmes, near Buenos Aires, and lived on the pampas for thirty-three years, after which he returned to England, where for years he lived in London in poverty, to such an extent that in 1901 he was granted a civil list pension. This he relinquished, however, when belated success reached him. There is no need to relate the titles of Hudson's well-known works which achieved such outstanding popularity. His bird books are probably the best known. A bird sanctuary, with a decoration by

Epstein which has caused considerable controversy, was placed to his memory in Hyde Park, London, in 1925.

In the presence of the British and United States Ambassadors, a bronze plaque was unveiled on August 3 to the memory of Hudson at Berazategui, in the province of Buenos Aires, to commemorate the centenary of the writer's birth. Dr. Fernando Pozzo, president of the Committee of Homage, announced the foundation of the Association of the Friends of Hudson, the chief objects of which will be to acquire the property of Veinte y Cinco Ombues, in Quilmes, the suburb of Buenos Aires where Hudson was born, and to create there a bird sanctuary and a museum of ornithology.

Feeding-stuffs in War-time

THE present position and prospects of home-produced feeding-stuffs in Great Britain have already been reviewed in NATURE (**146**, 251, 362, 712; 1941). Supplementing the papers by Dr. Norman Wright, the Imperial Chemical Industries Research Station at Jealott's Hill has published a bulletin (No. 3) on the same subject, which, as it is written largely in non-technical language, will be especially valuable to farmers, and to others who wish to know the facts before they express opinions on Government policy. Much of the bulletin is devoted to the various ways in which concentrated feeding-stuffs hitherto imported can be replaced by home-grown fodders, and the authors set out to show how the entire present deficiencies can be made good by greatly increased cultivation of oats, barley, peas and beans, by better manuring of grass and fodder crops, by making some six million tons of silage, and treating two million tons of straw with caustic soda to make it into a palatable and digestible carbohydrate feed. Incidentally, they remark that a large proportion of the four million acres of grassland ploughed up in the last two years was land in poor condition and low in fertility, and that without the aid of fertilizers the sanguine expectations of many are likely to be disappointed.

The authors may be somewhat unduly optimistic in their estimates of present potentialities, and also in their assertion that "the belief that there must be a considerable reduction in the number of livestock during the war is the policy of the defeatist". In the War of 1914–18, livestock were slaughtered in Germany and in Britain at a time when both countries were 'all out' for victory, and history is now repeating itself. A useful feature of the bulletin is the comparison of conditions in the year 1875—when British agricultural production was at its height—and in 1938, for it gives some indication of present possibilities. It is recalled that about a century and a half ago, Sir John Sinclair, president of the then Board of Agriculture, warned the country against over-reliance on imported feeding-stuffs, stating that "in times of war our great domestic foe will be our grasslands, which are producing in the most favourable cases only one-fortieth of what we are able to produce under high arable cultivation, which are dependent for their boasted livestock production on vast imports of foreign feeding-stuffs and which, in the case of emergency, will prove one of the weakest links in our national defences". The warning, as is well known, has passed unheeded by those responsible for agricultural policy, with the result that in 1941, as in 1917–18, we are hard put to it to feed our stock and people.

Committee on Agricultural Education

MR. R. S. HUDSON, Minister of Agriculture, has announced that, after consultation with the late President of the Board of Education, he has appointed the following committee to examine the present system of agricultural education, and to make recommendations for improving and developing it after the War: Lord Justice Luxmoore (chairman), Mr. H. Beaumont, M.P., Mr. W. J. Cumber, Mr. Ifor L. Evans, Mr. W. M. Goodenough, Dr. T. Loveday, and Mr. J. M. McClean. Mr. A. R. Whyte, of the Ministry of Agriculture, and Mr. Ronald Ede, secretary of the School of Agriculture, Cambridge, will be joint secretaries to the Committee, and Dr. G. K. Sutherland, of the Board of Education, will act as assessor. Mr. Hudson added that the committee would cover the main work of elementary and secondary school education, and the various types of training required in the different categories of education to include farmers, landowners, bailiffs, farm-workers, land agents, teachers, and technical advisers.

Uses of Wood in Warfare

WOOD wins wars, despite the apparent primacy of metals. This was the subject of an address by Mr. G. W. Trayer of the U.S. Forest Service on June 25 at the midsummer meeting of the American Association for the Advancement of Science. Wood has the further advantage over metals that it can be grown as a renewable crop if good forestry practice is observed, whereas metals are definitely limited and exhaustible resources. Even in aeroplanes, where aluminium and magnesium have replaced the spruce and fabric of the earlier machines, wood is being used again. Plastic-bonded plywood is coming to the rescue of an industry affected by a shortage of light metals. Smaller aeroplanes of this revolutionary new construction, with laminated wooden propellers, have been proved entirely practicable for training purposes.

A modern army's needs for wood are almost beyond counting. They range all the way from lumber for barracks and heavy timber for bridges to wooden poles for holding up camouflage nets and wooden crates for the safe transport of ammunition. Chemical uses for wood are important in warfare. Wood pulp can supply cellulose for nitrating into explosives quite as good as that derived from cotton linters. Black powder, still used to a limited extent in modern war, contains charcoal as an essential ingredient. More important, compressed wood charcoal is now replacing coconut-shell charcoal in the canisters of gas masks.

A Major Cause of Hay-fever

Extraction from ragweed pollen of a colourless, nitrogen-containing chemical believed to be one of the major causes of hay-fever was announced by Prof. Harold A. Abramson and Dr. D. H. Moore of the Columbia University School of Medicine and Dr. H. H. Gettner of Mount Sinai Hospital, at the Wilder D. Bancroft Colloid Symposium held at Cornell University under the auspices of the National Research Council and the American Chemical Society on June 20. The molecular weight of the chemical was found to be "surprisingly low—only 5,000". This small size is significant, it appears, from the explanation that in order to produce hay-fever, pollen must not only be blown into the nose and eyes, but also the molecules causing the symptoms must pass through the mucous membranes into the deeper tissues beneath. "Our study indicates that the ease with which allergic individuals will become sensitized to the contents of pollen grains may depend to a great extent upon the small size of the allergenic molecules which have now been isolated and studied quantitatively by electrophoresis, by ultracentrifugation, and by diffusion experiments for the first time".

Industrial Research Bureau, India

The report of the Industrial Research Bureau of the Government of India for the year 1939–40 (Delhi: Manager of Publications. 1*s.* 9*d.*) refers to the reorganization entailed by the decision to curtail severely plans for expanding the staff of the Bureau and the Government Test House. The Industrial Research Bureau and Research Branch of the Government Test House have now been merged by the formation of the Board of Scientific and Industrial Research and the office of the Director of Scientific and Industrial Research, the first director being Sir Shanti Swarup Bhatnagar. The report on the work of the Industrial Research Council refers to investigations carried out on oils and soaps as well as on the development of the glass industry, and particularly to progress made in the designing and installation of improved glass-melting furnaces. Progress has been made in the survey of deposits of glass-making materials as well as in the survey of the oil-seeds crushing industry.

In regard to the co-ordination of the universities and research institutions in India with the development and extension of industrial research, attempts are being made to obtain the co-operation of the universities in preparing the combined list of industrial researches completed, in progress and proposed to be undertaken in Government laboratories, universities and research institutions in India. Publication of an annual combined list is contemplated. The report on the work of the Industrial Research Bureau also refers to the co-ordination of universities and research institutions. The number of laboratories in India capable of undertaking industrial research work is limited, and after considerable attention had been given to the matter it has been decided to provide funds to be allocated to selected institutions for the payment of grants to workers engaged in research falling within the programmes to be arranged on the recommendations of the Board of Scientific and Industrial Research.

The Indian Lac Research Institute has continued its work on the development of moulding powder compositions containing a considerable percentage of shellac. The Research Branch of the Government Test House has continued its investigations on paints, particularly on accelerated weathering, paint formulæ, fungus growth on paints, and the physical properties of paint films. Work on the factors affecting the properties of dry cells has been continued during the year and some correlation established between the chemical constitution and electrical performance of ores. An automatic cooking machine for dry cells has been designed and constructed in the laboratory. Work on vegetable oils as lubricants has indicated that phenyl-α-naphthylamine, as.-diphenyl-hydrazine, *p*-toluidine and phloroglucinol are the most effective stabilizers for castor oil and rape-seed oil in the presence of iron. A number of blends were prepared for engine tests, and details of these trials are included. Other work has covered the use of vegetable oils as Diesel fuels, building materials, particularly the use of Surkhi as pozzolana.

Trees of the Past

A short interpretation of the fossil herbaria of the rocks by the late Sir Albert Seward (*J. Roy. Hort. Soc.*, 66, Pt. 6, June, 1941) provides a useful epitome of palæobotanical knowledge. The paper deals particularly with trees, and the story commences with *Cercidiphyllum japonicum*, an Eocene fossil species which is still indigenous in China and Japan. Cretaceous strata brought the first geological appearance of the genus Magnolia. Tulip-tree, plane, hazel and oak are present-day trees with stratigraphical antiquity. The maidenhair tree, *Ginkgo biloba*, is one of a group of plants which flourished in the Jurassic and Triassic periods. It is curious that many trees which now only appear in China and Japan were inhabitants of Europe and North America in earlier geological time; west and east seem to have changed places. The Norfolk Island pine, *Araucaria excelsa*, also had a divergent distribution in the past, for fossil leaves, cone scales and seeds were discovered in 1931 from Tertiary sediments in the Kerguelen Archipelago, where now is found only a scanty flora of flowering plants, ferns, mosses and lichens, but no trees.

Wild Flower Society

The 264th issue of the Wild Flower Society Magazine is an enlarged double one covering January–June 1941, an evidence of the Society's decision to carry on during war-time. Many contributors stress the danger of the Women's Institutes' Herb Scheme exterminating rare British plants unless the Government-encouraged collection of wild drug plants is botanically supervised. The chief paper in the issue is the first supplement to Green's "Flora of Liverpool"

which Mr. Eric Hardy has drawn up for the Merseyside Naturalists' Association. Covering botanical vice-counties 58 and 59, it adds new records of a number of plants. The increase of a hermaphrodite form of *Bryonia dioica* on the Lancashire dunes, a new unnamed Œnothera hybrid and the extinction of *Rumex cuneifolius* (first recorded in Britain from west Cheshire, 1913) are also noted.

Biological Investigations at Palao

THE first part of the second volume of the "Studies of the Palao Biological Station" contains seven reports relating to corals, detailed descriptions of four species of Pheretima (Oligochæta) and an examination by Y. Haneda of the luminescence of shore fishes of the genus Leiognathus. In these latter the luminous body is in the form of a ring surrounding the œsophagus where it enters the body cavity. The light in the eleven species examined passes through the muscles, which are milky white and translucent. The gland has two openings from the œsophagus. Through these, luminous cocci enter and settle down, the response to outer stimuli being rapid.

Three reports deal with the biochemistry of corals, and Motoda compares the conditions in the open sea with those in the lagoon; these are preliminary reports. Motoda also studies the growth-rate of a massive coral (Goniastrea) by the multiplication of its polyps. It is a coral of the reef flat and thus subjected to tidal waters, which are studied in respect to temperature, salinity, oxygen content, *p*H and exposure to air. The oxygen production by ten polyps under varied conditions of light and depth, this due to their symbiotic algæ, gives 0·22–0·14 per hour at a depth of 6 cm. in clear weather, while under thick clouds 0·08 c.c. is consumed. Direct exposure to the sun's rays in air is successfully resisted for two hours, but nearly all polyps are killed after six hours. The growth-rate decreases with age, but most colonies died before the second count. It had previously been suggested that this decrease is correlated with reproductive activities, but this is not considered. Finally, Abe's work on Fungia is interesting as dealing with the effect of sediments.

School Hygiene in São Paulo

THE School Health Service of São Paulo, Brazil, claims to be one of the oldest, if not the oldest, child welfare institution. By a decree of December 28, 1938, the service has been reorganized, with the enlargement of existing facilities and the creation of other services including those of mental hygiene and child guidance clinic, allergy clinic, endocrinology and nutrition clinic, dermatology and syphilis clinic, educational puericulture for students of normal and professional schools, X-ray and laboratory services, etc. During the first half of 1939 the Service, which is under the Department of Education, attended 94,108 children, made 2,286 health examinations at headquarters and 42 at home, 1,426 vaccinations at headquarters, attended 39,144 children in the Largo de Arouche School Polytechnic, 4,216 in the eye service, 5,369 in the otorhinolaryngology service, 388 in the dermatology and syphilis clinic and 3,819 in the X-ray clinic. In the School Groups, 26,276 children were examined.

Vital Statistics in New Zealand

ACCORDING to the annual report of the Royal New Zealand Society for the Health of Women and Children founded by the late Sir Truby King, the birth-rate of the Dominion in 1939 (excluding Maoris) was 18·73 per 1,000, the highest recorded since 1930. The maternal mortality-rate, excluding septic abortion, was 2·95, and the infantile mortality-rate 3·14 per 1,000 births, almost the lowest ever recorded. The death-rate during the first month of life was 21·8, an improvement on the figure for recent years. The Society has six infants' hospitals in various parts of New Zealand, and the 138 Plunket nurses in its service saw 22,000 new cases during the most recent year and paid 170,000 visits to homes.

The National Trust

THE report of the National Trust for the year 1940–41 shows the unique position attained by this society devoted to the preservation of places of historic interest or natural beauty. Not only are bequests of land coming to the Trust upon an increasing scale, but the recent Country Houses Scheme has received important support in the transfer of the beautiful Blickling Hall, Norfolk, and its large estate, to the control of the National Trust. In the terms of Lord Lothian's will the freehold is vested in the Trust on the condition of preserving the amenities, and with the request that in the choice of tenant preference shall be given to descendants of the donor, subject to facilities for the access of the public. Death duties on large estates are now on such a destructive scale that the preservation of England's noble mansions, their period furniture, and surrounding parks can only be ensured by their transfer to a permanent society such as the National Trust.

Fire Risks in Railway Trains

THE report which Colonel A. C. Trench has presented to the Ministry of War Transport on the fire in which six schoolboys lost their lives and which destroyed three coaches of an express train on the L. and N.E. Railway on April 28 should not disturb faith in the general safety of railway travel in Great Britain. It is unfortunate, as is pointed out in *Engineering* of July 11, that, in the interests of economy, the reports of inquiries into the causes of railway accidents are no longer being published and circulated in the usual manner. This is doubly regrettable, for the account of the tests carried out by Colonel Trench, in spite of war conditions, is good evidence of the morale of the country.

The train in question was travelling at about 55 miles an hour when the fire began; it was stopped in about a mile and a quarter, by which time the fire had taken a firm hold on one coach. Colonel Trench refers in his conclusions to the locking of doors of unoccupied vans and of gangway and corridor doors. He also suggests that the wadding

and the outer rexine covering on the backs of the railway seats, where the fire in this case began, might be omitted. It is evident that the main lessons of this fire require to be studied by the travelling public in general rather than by the railway companies or their employees. The carelessness habitually displayed by many passengers in the disposal of matches and cigarette ends is quite inexcusable; nevertheless, the provision of more and larger 'ash trays' might be considered.

Making Light for To-morrow

THE *Electrician* of July 4 quotes Mr. S. G. Hibben, director of applied lighting to the Westinghouse Lamp Division, as attributing most of the very rapid progress being made in developing illuminants to the influence of the large 'fairs' recently held in the United States. Each exhibition has been identified with some new and often radical means of producing light. The Panama-Pacific Exposition of 1915 ushered in the use of tungsten filament lamps of large wattage for exterior floodlighting, and coloured beams from carbon-arc searchlights. In 1926 the Philadelphia Sesqui-Centennial Exposition presented colour-coated incandescent filament lamps with spirally coiled filaments surrounded by inert nitrogen and argon, in sizes down to and including the commercial 60-w. lamp. High voltage (10,000 volt range) neon and mercury tubing for architectural decoration were also used. The high-intensity mercury vapour lamps were publicly introduced into the United States at the Chicago Century of Progress Exposition in 1933.

Noteworthy above all others, the New York World's Fair of 1939–40 introduced in that country the radically new and efficient fluorescent lamps. In addition, there were also introduced new sizes of mercury vapour lamps for the illumination of foliage, the production of short-wave visible colours for underwater fountain lighting, new projector lamps, and the popularly termed 'black-light' lamps or long-wave ultra-violet illuminants. The latter of these gave a wide variety of fluorescent effects. Whilst attention is naturally focused on the new or unusual illuminants, it has to be remembered that the familiar incandescent lamp is, and for many years to come will be, the basic, most commonly used lamp for work requiring light primarily. More precise manufacturing methods and lower costs now give the purchaser two and a half times as much light for the same money, as compared with 1928.

Seismological Data from India

VALUABLE seismological data is contained in the *Seismological Bulletin* of the Government of India Meteorological Department for the period January–March 1940, published under the direction of Dr. C. W. B. Normand. Interpretations of the seismograms obtained at the observatories at Agra, Bombay, Calcutta, Colombo, Dehra Dun, Hyderabad and Kodaikanal are given in considerable detail, and it is pleasing to note that J. H. Sil at Poona has again collected non-instrumental reports from voluntary observers. At the Upper Air Observatory at Agra, ninety-four earthquakes and tremors were recorded instrumentally during the quarter, and in each case there are given the type of wave with its arrival time, occasionally its period and amplitude, together with the estimated epicentral distance and depth of focus. The deepest focus shock recorded was apparently one approximately 200 km. deep estimated by the Brunner Chart, on March 28, at an estimated epicentral distance of 4,135 km. The other observatory reports are along similar lines. Fifteen earthquakes were recorded by voluntary observers. Three of these reached intensity 7 on the Rossi-Forel scale. These were at Srinagar on January 26, Gauhati on February 13 and Drosh on March 19, the latter also being recorded with lesser intensities at Kabul, Peshawar and Srinagar.

Announcements

THE Bisset-Hawkins Medal of the Royal College of Physicians has been awarded to Sir Frederick Menzies for his work as chief medical officer of the London County Council, and the Baly Medal has been awarded to Prof. Edgar Allen, of Yale University, for his work on œstrogens.

PROF. JEAN PERRIN, formerly professor of physical chemistry in the University of Paris, has been invited to become visiting lecturer at Wilson College, Chambersburg, U.S.A., during the academic year 1941–42.

THE South African Institute for Medical Research in Johannesburg is about to undertake the manufacture of yellow fever vaccine under the directions of Dr. G. M. Findlay of the Wellcome Research Institute of London.

THE American Society for X-Ray and Electron Diffraction, plans for which were announced in *Science* of May 23, starts its existence with a charter membership of 124. The officers elected for 1941 are: *President*, Dr. M. L. Huggins, of the Eastman Kodak Company; *Vice-President*, Prof. B. E. Warren, of the Massachusetts Institute of Technology; *Secretary-Treasurer*, Dr. George Tunell, of the Geophysical Laboratory, Washington, D.C.

THE British Association's Division for the Social and International Relations of Science is arranging a meeting to be held, if circumstances allow, on September 26, 27 and 28. Various subjects under the general heading of "Science and World Order" will be dealt with. The first day's session will take place, by kind permission, in the theatre of the Royal Institution, Albemarle Street, London, and those of the second and third days, it is hoped, at the Rothamsted Experimental Station, Harpenden.

DR. KENNETH M. SMITH writes: "In a recent review entitled 'Insects and Plant Diseases' (NATURE, July 19, p. 65), through an error in proof-reading, it was made to appear that 1801 was the date of the first discovery of bacteria as a cause of plant disease. This should, of course, be 1881, eleven years before the first demonstration of a virus by Iwanowsky in 1892."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Structure of Cobalt

POWDER photographs of hexagonal cobalt do not always have consistently sharp lines, and the variation of sharpness is not explainable by internal strains or by small particles of unusual shapes. This may be seen from the following table of visual estimates of the breadths of the various lines on a photograph taken with nickel $K\alpha$ radiation.

$h\ k\ i\ l$	Description	$h\ k\ i\ l$	Description
$1\ 0\ \bar{1}\ 0$	sharp	$1\ 1\ \bar{2}\ 2$	sharp
$0\ 0\ 0\ 2$	sharp	$2\ 0\ \bar{2}\ 1$	broad
$1\ 0\ \bar{1}\ 1$	broad	$0\ 0\ 0\ 4$	sharp
$1\ 0\ \bar{1}\ 2$	broad	$2\ 0\ \bar{2}\ 2$	very broad
$1\ 1\ \bar{2}\ 0$	sharp	$1\ 0\ \bar{1}\ 4$	very broad—almost invisible
$1\ 0\ \bar{1}\ 3$	very broad		
$2\ 0\ 2\ 0$	sharp	$2\ 0\ \bar{2}\ 3$	very broad

We have examined the problem by means of powder and oscillation photographs and have found that the following theory is capable of explaining the observations.

It is well known that the close-packed structures can be derived from three types of close-packed planes of atoms; the co-ordinates with respect to the two hexagonal axes of the atoms in each plane are:

$$(0, 0) \ldots A\,; \quad (1/3, 2/3) \ldots B\,; \quad (2/3, 1/3) \ldots C.$$

In a normal hexagonal structure only two of these types are used, thus: *ABABAB* . . ., but it is easy to see that faults may arise and that the sequence may change to *CBCBCB* . . ., or to *ACACAC* . . . If such faults occur frequently the structure will be irregular, but certain sets of planes, such as the (0001)'s, will obviously remain perfect. In general, all sets of planes with $(h\text{-}k)/3$ integral will be perfect, and this is in accordance with the observations in the accompanying table.

From the broadening of the lines an estimate of the degree of imperfection can be made, and it was found that in the specimen which was examined the probability of a mistake occurring was as high as 1/10.

The same kind of theory is applicable to other problems, notably the broadening of the superlattice lines in $AuCu_3$ due to the presence of small 'antiphase domains' in single crystals.

A more detailed account of the work on cobalt will be published elsewhere.

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July 14.

Wave Form of Atmospherics

SEVERAL investigators[1,2,3] have shown that an atmospheric often has a characteristic 'slow tail' of a few milliseconds' duration, in addition to the customary wave train of a few cycles of frequency about 10^4 cycles per second. The latter has been associated with the return stroke of the lightning discharge, and precision has recently been given[4] to this suggestion by the calculation of the amplitude and duration of one cycle of this wave from the characteristics of the return stroke, the remainder of the wave being presumably due to reflexions from the ionosphere[5].

As to the 'slow tail', Appleton and Chapman[2] have suggested that this is connected in some way with the slow *c* portion of the lightning discharge. A study of the electrostatic field changes caused by near strokes recorded by these authors[2], however, suggests that the 'slow tail' is the result of the radiation due to the destruction of electric moment during both the *a* and the *c* portions of heavy strokes, an explanation which is supported by the occurrence of the high-frequency radiation due to the *b* portion within the 'slow tail', observed at relatively near distances[1]. The durations involved are obviously of the right order, being in each case a few milliseconds. As to the amplitude, my theory[6] of the increasing corona current as the leader stroke approaches the earth yields, from the relation

$$\varepsilon_r = \frac{1}{c^2 r_{\_}} \, \frac{d^2 M}{dt^2},$$

a final value of the order of 10 or 20 millivolts/metre for the radiation field due to the *a* portion at 100 km., assuming that the corona current increases as the square of the voltage. During the *c* portion a charge of the order of 10 coulombs often flows from cloud to earth in a time of the order of 3 milliseconds[4]. If this charge is initially at a height of 2·5 km., and if its electric moment is destroyed exponentially, which the aforementioned records[2] show to be approximately the case, then the above relation yields a crest value for ε_r at 100 km. of the order of 70 mv./m. These values compare well with the observed value of 125 mv./m. at 100 km.[1].

It would thus appear that the 'slow tail' represents the radiation resulting from the destruction of the electric moment during the *a* and *c* portions of a lightning stroke.

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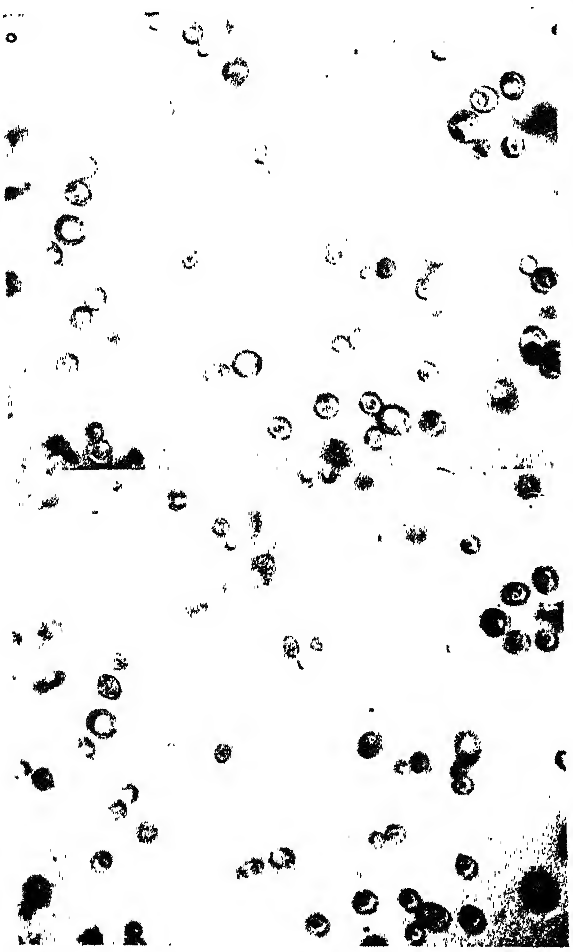
Increased Ultra-violet Absorption of Cells Following Irradiation with Ultra-violet Light*

PREVIOUS investigations[1] have indicated that one of the responses of cells to various injurious agents (for example, lethal ultra-violet light and X-rays) is the release into the intercellular fluids of nucleic acid-like proliferation-promoting factors ('intercellular wound hormones'). Considerable evidence indicates that these active factors are produced in the living cell as a response to injury[2]. The present investigations were aimed at determining by direct observation of living cells whether there is an actual increase in cellular nucleic acids, purines or pyrimidines, during the course of injury. For this purpose, ultra-violet photomicrography was employed, following techniques well established by Caspersson[3].



TWO ULTRA-VIOLET PHOTOMICROGRAPHS OF *S. cerevisiæ* FROM A TYPICAL SERIES, SHOWING INCREASED ABSORPTION OF ULTRA-VIOLET FOLLOWING IRRADIATION WITH SUB-LETHAL DOSES ON THE MICROSCOPE STAGES AT $\lambda = 2800$ A. ABOVE, BEGINNING OF EXPERIMENT; BELOW, SAME FIELD ½ HR. LATER.

A Zeiss quartz microscope was used, with 2·5-mm. glycerine immersion objective, 10× eyepiece, and quartz double monochromator illuminator. A cadmium spark light source was used for $\lambda = 2800$ A. and a General Electric type *H*-3 high-pressure mercury arc for $\lambda = 2537$ A. A hole cut in the outer glass jacket of the mercury arc permitted passage of the ultra-violet. The organism was *S. cerevisiæ* (Fleischmann bakers' yeast). This was suspended in isotonic salt solution or water, sealed under a quartz coverslip on a quartz slide, and irradiated continuously on the microscope stage with the lethal radiation employed as the microscope illuminant. Photomicrographs were taken at the beginning of the experiment, and at fifteen-minute intervals during the course of irradiation.

The plates showed a progressive increase in the ultra-violet absorption of the cells during irradiation. Since the wave-lengths employed were in the range highly absorbed by purines and pyrimidines[4], one can interpret the results as indicating a production by the injured cells of nucleic acid-like materials. This is consistent with the previous results[2] indicating that proliferation-promoting intercellular hormones are produced in living, injured cells as a response to injury. Two photomicrographs from a typical series are shown in the figure.

In Mitchell's studies of the possible relationship of nucleic acids to the radiosensitivity of tumours, he found an increase in the ultra-violet absorption near 2600 A. of carcinoma tissue and normal epithelium irradiated with X-rays or gamma rays *in vivo* and afterwards examined in section by ultra-violet photomicrography. He interpreted the increased absorption as due to purines or pyrimidines, and not to thymonucleic acid (negative Feulgen reaction). From *in vitro* experiments, he concluded that the effect was not due to direct photochemical changes in the cytoplasm. The supposed purine or pyrimidine nature of the absorbing materials, their apparent production as a result of the effects of lethal agents (X-rays and gamma rays), and their evident formation by living, injured cells rather than as a direct photochemical effect, all suggest that Mitchell was observing the production of the proliferation-promoting factors we have been investigating. If this is true, it points to the advisability of a careful study to determine whether the production of proliferation-promoting factors by injured cells is an initial result of the irradiation of tumours by X-rays and gamma rays. The release of such factors into the tumour mass and surrounding tissues might conceivably play an important part in the variability of the response of tumours to irradiation.

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May 27.

* Contribution No. 185 from the Department of Biology and Public Health, Massachusetts Institute of Technology.

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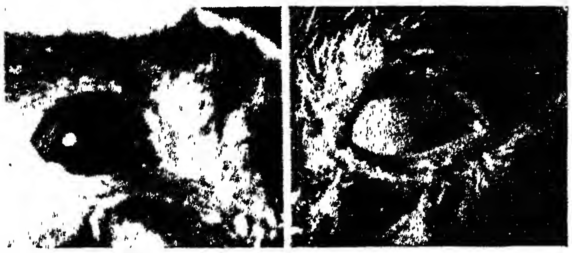
Local Treatment of Experimental Pyocyaneus Ulcers of the Cornea with Albucid Soluble

JOY[1] recently demonstrated that the development of experimentally produced ulcers of the cornea in rabbits could be favourably influenced by the parenteral administration of sodium sulphapyridine. It has also been shown that sulphanilamide penetrates freely through the cornea[2,3].

We have investigated the effect of local application of a water-soluble sulphonamide on experimental ulcers in seventeen rabbits. In each animal a definite area in both eyes was denuded of epithelium by means of a discission needle. Great precautions were taken to ensure that the lesions were equal in both eyes. A 24-hour culture of *B. pyocyaneus* (kindly supplied to us by Dr. Oag, of the Department of Bacteriology of the University of Edinburgh) was then applied to these denuded areas by means of a metal loop; the same strain of *B. pyocyaneus* was used throughout all the experiments.



(*a*) (*b*)

Fig. 1.

SHOWING THE CONDITION OF THE CORNEA IN THE TREATED (*a*) AND CONTROL (*b*) EYES OF A RABBIT ON THE THIRD DAY AFTER THE PRODUCTION OF THE LESION.

Treated eye: cornea healed and showing only a small superficial scar situated at the centre of the cornea immediately adjacent to the light-reflex which is overlying the margin of the pupil. Control eye: severe abscess involving half the cornea.

One hour after the application of the culture several drops of a 30 per cent solution of albucid soluble (which forms a neutral solution) were applied to the cornea of one eye in each animal, the other eye being used as a control and receiving several drops of saline. This treatment was continued four times a day until the lesions were quiescent.

In the majority of the 'control' eyes extensive ulceration occurred and a complete or partial 'ring abscess' developed, the end result being either perforation or gross scarring of the cornea with extensive pannus formation. In some animals, however, the ulceration was limited to the site of scarification, and the resultant scar was very little larger than the original lesion.

In every animal the lesion in the control eye was more severe than that of the treated eye. In eleven animals the difference was very marked (see accompanying illustration), in four animals the difference was less marked, but the treated eye was still definitely better than the control, while in two rabbits the treated eye was only slightly better.

The extent to which ulceration or abscess formation occurred in the cornea is summarized in Table 1.

It is noteworthy that a partial or complete ring abscess developed in twelve of the control and in only three of the treated eyes. Hypopyon was observed in five of the control eyes and in only one of the treated eyes.

TABLE 1.

	No ulceration.	Ulceration present but not extensive.	Extensive ulceration, abscess formation, or necrosis, with or without perforation.
Control eyes	0	4	13
Treated eyes	11	4	2

Conjunctivitis did not play a prominent part in the lesions produced, but again the treated eyes were on the whole very definitely better than the controls, and in no case was the treated eye worse than the control eye of the same animal. The results are shown in Table 2.

TABLE 2

CONJUNCTIVITIS

	Nil	Slight	Moderate	Severe
Control eyes	0	10	6	1
Treated eyes	10	6	0	1

The expenses of this investigation have been defrayed by the W. H. Ross Foundation for the Prevention of Blindness. We are greatly indebted to Mr. Edwards, of Messrs. Schering, London, for the supply of ampoules of 30 per cent solution of albucid soluble.

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Sulphanilylbenzamide in the Chemotherapy of Bacillary Dysentery

SULPHANILYLGUANIDINE, first described in 1938[1], was recently introduced by Marshall and his colleagues[2] in the treatment of bacterial infections of the intestinal tract. A subsequent report[3] dealt with the successful trials of this compound in acute bacillary dysentery due to Flexner and Sonne types in children. The use of the drug is based on its potent antibacterial properties, its solubility in water and its poor absorption from the gut. We have re-examined a large number of drugs of the sulphanilamide and sulphone classes having similar characteristics and have found two soluble compounds, 4: 4'-*bis*-γ-phenyl-*n*-propylaminodiphenylsulphone tetrasodium sulphonate and sulphanilylbenzamide to be more effective *in vitro* than sulphanilylguanidine. However, when these compounds were incorporated in the diet of mice, only sulphanilylbenzamide was as efficient as sulphanilylguanidine in its antibacterial action on the coliform organisms of the gut. When fed to rabbits by stomach tube, sulphanilylbenzamide is poorly absorbed, but it is absorbed to the extent of one and a half times that of sulphanilylguanidine.

Our *in vitro* tests compared the antibacterial activity of constant drug concentrations in a stock broth against graded inocula of selected intestinal

pathogens. The range used included strains of Sonne, Flexner, Newcastle, Shiga, coli, typhoid and cholera. We have always found Sonne strains to be the most resistant to sulphanilylguanidine and Shiga and typhoid strains somewhat resistant, while sulphanilylbenzamide has proved highly potent in all types. The mouse test referred to above is one suggested by Marshall[2]. It is based on the reduction in the concentration of the lactose-fermenting organisms in the fresh stools of mice fed on a diet containing 2 per cent of the drugs. Fresh fæces are made into an emulsion containing approximately 50 mgm. in 5 ml. of broth and graded dilutions made on desoxycholate agar plates. The lactose-fermenting organisms are counted after twenty-four hours. Under these conditions sulphanilylbenzamide is as efficient as sulphanilylguanidine.

Whether the promising *in vitro* results, especially against Sonne, Shiga and typhoid types, are reproducible in man will in turn depend on whether the more rapid absorption of sulphanilylbenzamide from the gut is significant. Arrangements for such a clinical trial are being made.

It is hoped to publish a detailed account of this work elsewhere.

We have to thank Mr. T. Dewing of the Wellcome Chemical Works, Dartford, for kindly supplying sulphanilylbenzamide and Mr. W. H. Gray of the Wellcome Chemical Research Laboratories for kindly supplying 4 : 4'-*bis*-γ-phenyl-*n*-propylaminodiphenylsulphone tetrasodium sulphonate.

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Latero-sensory Canals and Dermal Bones

J. A. MOY-THOMAS[1] has recently made important observations on the developmental relationship between the frontal bones and the supraorbital latero-sensory canal in Salmo, and clearly considers that his experiments go far to destroy the whole basis of the homologization of dermal bones in fishes by reference to the latero-sensory system. His results are quite in harmony with, for example, Kindred's embryological study of Amiurus[2], and no doubt somewhat similar conditions occur widely in teleosts, where the dermal bones of the skull-roof, particularly the frontals, play an important part in the mechanical structure of the cranium.

It is true that some workers have carried the use of the latero-sensory too far, especially where originally enclosed canals show a phylogenetic 'degeneration' to pit-lines, and I have several times[3,4,5,6] noted necessary modifications to some of these rigid schemes. Nevertheless, in certain primitive fossil forms, and in the development of Amia (Pehrson[7]), there is abundant and convincing morphological evidence of a close developmental connexion between certain dermal bones and the latero-sensory system (excluding pit-lines). In the most primitive known Actinopterygii, Crossopterygii and Dipnoi the adult dermal skull-roof consisted of bony plates, occupying the whole thickness of the corium, but having no part in the mechanical construction of the cranium; somewhat similar conditions still hold in Amia. But in most teleosts (Actinopterygii) and in all but the most primitive tetrapods (from Crossopterygii), several of the dermal bones have new functions as mechanically important cranial elements, and may become deep-seated. It is precisely in these forms that the importance of latero-sensory canals as 'markers' of dermal bones is so greatly reduced. I am therefore unable to accept all Moy-Thomas's conclusions. His experiments should be repeated on Amia before such deductions can be drawn with confidence.

Moy-Thomas's findings are not unexpected. The early Crossopterygii, and probably the earliest tetrapods, are generally considered to show a close relationship between some of the dermal bones and latero-sensory canals; but in higher tetrapods latero-sensory canals fail to develop, and dermal bones such as the frontals form part of the mechanical structure of the skull. What seems to have been, in primitive forms, a simple 'secondary organizer' relationship involving early formed latero-sensory structures and certain later developed dermal bones, is replaced in tetrapods by apparently more complicated processes, in which the more integrated architecture of the cranium is clearly an important factor. The same may prove to be true of many Teleostei, and it seems likely that a programme of experiments like those of Moy-Thomas, applied to a large series of teleosts and to Amia, Lepidosteus and sturgeons, would provide valuable evidence in the important problem of the changes in organizer-reactions involved in the gradual modification of phylogenetically archaic structures to meet new needs.

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Function of the Ventral Tube in *Onychiurus armatus* (Collembola)

VERY little is known about the function of the ventral tube of Collembola. Until recently it has been regarded as an adhesive organ, but the observations of W. M. Davies[1] suggest that in *Sminthurus viridis* (Linn.) at least, it may be used for cleansing the body and as a means of transferring drops of water from the surface of the body to the mouth where they are then absorbed. In connexion with this, Davies has suggested that 'free water' is essential for the survival of this species, even in a water-saturated atmosphere.

It is interesting, therefore, to record some results obtained with the soil-living Collembola, *Onychiurus armatus* (Tullb) under various culture conditions.

Onychiurus armatus has been maintained on Mucor cultures on agar media in Petri dishes where it moved freely over the vertical and horizontal surfaces without using the ventral tube vesicles. When placed on vital stains in various humidities the stain was

absorbed through the ventral tube, and the lower the humidity the more rapidly was the stain taken up. The distal joints of, in particular, the hind limbs, which were immersed under these conditions, also became stained.

On agar blocks, where only the tips of the legs and the ventral tube vesicles were in continuous contact with the agar surface, in a low humidity the animals survived for a much longer period than when in the same humidity but on a dry surface. The extrusion of the vesicles was only sufficient to reach the surface of the agar and no action of the vesicles comparable with that observed in *Sminthurus viridis* by Davies, has been seen. Puncturing the vesicles had the effect of reducing greatly the length of life except in a saturated atmosphere.

Onychiurus armatus apparently has no mechanism for preventing water loss, and the ventral tube vesicles seem to be the primary water-absorbing organs.

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Relative Growth in the Individual

WITH regard to A. E. Needham's communication[1] stressing the desirability of obtaining relative growth data on individuals as distinct from contemporaneous data obtained in populations, we would like to point out that such data relating to guinea pigs were published by us some time ago[2]. We then demonstrated the isometry of teat-length against body-length in the young male guinea pig and the occurrence of 'simple' allometry of the teat under androgenic stimulation. In these experiments data for groups of comparable individuals were averaged.

More recently[3] we have published a preliminary account of teat-growth data obtained on individual goats, showing that in the young female a phase of teat isometry is succeeded by a phase of 'simple' positive allometry; the constant α was found to vary among individuals. A more detailed account of these last observations is in the press[4].

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Miocene Deposits in Kenya

IN 1935 I examined the Miocene deposits of Kavirondo, Kenya, but as publication of results (already overdue) seems likely to be further delayed, I should be grateful for an opportunity to summarize the more important results with reference to misconceptions which have arisen about the age of the formation and its fauna.

The deposits are exposed in three main areas: Rusinga, an island on the edge of Lake Victoria, Karungu, originally described by Oswald[1], and Koru, farther east. The rocks are largely volcanic in origin, and in each case are associated with a major volcanic centre. On Rusinga the lower beds are fossiliferous clays with thin sandstones containing a small proportion of tuffaceous material; these are succeeded by tuffs with an intercalation of red clays and thin limestones, and the tuffs overlain in turn by agglomerate and nephelinite lava. The tuffs and agglomerates thicken rapidly towards the south-west, indicating as source the Gwasi volcanic centre of South Kavirondo. Adjacent islands provide confirmatory evidence of this. Karungu lies on the southern fringe of the same volcanic mass, and the fossiliferous beds there are correlated with the lowest beds of Rusinga. Koru shows a succession broadly similar to Rusinga, but red clays with limestones in the middle part provide the main fossiliferous horizon.

Bailey Willis[2] has argued that the Karungu deposits are fluviatile Pliocene, containing occasional derived Miocene fossils, and Broom[3] has recently queried the Miocene age of Proconsul from Koru on systematic grounds. It is therefore necessary to confirm, first, that the fossiliferous part of the formation is definitely lacustrine, secondly, that the fossils are truly autochthonous, being in some cases articulated and in most cases quite unrolled, and thirdly, that Dr. A. T. Hopwood and D. G. MacInnes, who have separately worked on the fauna, are quite satisfied that it is of Lower Miocene date.

Independent evidence indicating considerable age is provided by the later history of the deposits. On Rusinga the beds show strong deformation, including isoclinal folding and thrusting with production of phacoidal structures, which it is exceedingly difficult to explain other than by lateral compression (in this connexion Willis's theory of an expanding disk beneath Lake Victoria as the force which produced the Rift Valleys should be remembered). In particular, it may be emphasized that the phenomena are quite distinct from those of slumping, well-developed in neighbouring Pleistocene beds. Afterwards the deposits were intruded by igneous dykes, and in the west extensively eroded with relation to a base level beneath the present lake before the formation of high-level raised beaches in the Lower and Middle Pleistocene. Between deposition of the fossiliferous beds and the Lower Pleistocene, therefore, accumulation of up to 500 ft. of tuffs and agglomerates, extrusion of lava, disturbance of the beds, dyke intrusion and extensive erosion successively occurred, which supports the palæontological evidence in suggesting a date at least as early as Miocene.

This early disturbance of the African peneplain, previously doubted by some authorities, is further illustrated by the discovery of phonolite-covered Lower Miocene beds in a valley cut in the gneiss of the northern scarp of the Kavirondo Rift, which must, accordingly, be of pre-Miocene age.

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July 12.

[1] *Quart. J. Geol. Soc.*, **70**, 128-162 (1914).
[2] "East African Plateaus and Rift Valleys", pp. 148-150 (1936).
[3] NATURE, **148**, 14 (1941).

THE ONTARIO RESEARCH FOUNDATION

THE report of the Ontario Research Foundation for the year 1940 includes the Director's report together with the financial statment and a full list of publications to December 31, 1940. The Director's report refers to the new problems created for those engaged in agriculture, particularly to work concerned with remedying the slow depletion of the soil. The Foundation is studying areas which show evidence of trace-element depletion and also characteristic deficiency diseases, such as boron deficiency in the apple, sugar beet and turnip, copper deficiency in the onion and manganese deficiency in oats. A survey of land values in rural Ontario and their relation to soil, climate and economic factors has been commenced. The work on mastitis in cows has continued throughout the year and evidence has been secured proving that the leucocytes present in milk can destroy the characteristic bacteria which are associated with mastitis. A study of the pathological changes in the udder of the cow caused by tuberculosis and other diseases has been commenced.

In the late autumn the pathological and bacteriological staff were fully occupied in field studies of autopsies and laboratory work arising from a widespread outbreak of a respiratory disease among young pigs. Rapid and successful progress has been made in investigating the life-history of a parasitic fly which attacks and destroys the larvæ of the clothes moth. The research has indicated other problems related to the use of parasites for the destruction of pests and also to the nature of the physiological relation between the host and the parasite.

The work of the Textile Department has continued to expand, and much of its testing work in 1940 was in connexion with fabrics and other materials manufactured for war supplies. Co-operative work with various firms associated with the quality control plan, in which eighteen manufacturers of fabrics and eighty manufacturers of garments are now co-operating, has been concerned particularly with work on the relation between seam construction and serviceability, effects of different finishing processes on the strength of dress fabrics, a comparative study of length of life of wool socks and wool plus rayon socks and the influence of time and other factors on the extensibility of drapery fabrics. Work on the response of silk to water vapour has been extended to cover a number of organic substances such as alcohols, ethers and ketones.

The investigation of the principles of scouring has continued, while in the Division of Engineering and Metallurgy, in addition to important testing work, studies have continued on the resistance of various alloys to abrasion, the malleability of white cast iron in relation to variation in chemical composition and the influence of the cross-sectional area of a test piece on the fatigue strength as measured by the Avery machine.

The Chemistry Division has largely been concerned with analytical work in connexion with specifications, while in the Division of Biochemistry, research in the leather laboratory has been concerned with further improvements in the methods of intermediate alum and chrome re-tannage of heavy leathers. Work has continued on methods for the preparation of organic acids by fermentation as well as the preparation of pure lactic acid for edible and medicinal purposes. Much of the effort of the Biochemistry Division has been given to determinations of vitamins in mill and other food products. The Department is collaborating in the development of rapid cheap and reliable methods for the determination of vitamin B_1, and is already in a position to carry out accurately and economically biological or chemical assays of vitamins A, C, D and B_1 constituents and riboflavin.

USES OF THE 200-IN. TELESCOPE

DR. MAX MASON, chairman of the Observatory Council of the California Institute of Technology, speaking at a meeting in June of the Pacific Division of the American Association for the Advancement of Science and the Astronomical Society of the Pacific, stated that the great 200-inch telescope to be erected on Mt. Palomar is now approaching completion, thirteen years after the late Dr. George Ellery Hale convinced the Rockefeller Boards of the feasibility of such an instrument, and obtained funds for its construction. It will be recalled that Dr. H. Spencer Jones gave some details about this instrument in his Thomas Young Oration before the Physical Society (NATURE, June 14, p. 753).

The disk, about 17 ft. in diameter, originally weighed 21 tons, and during five years' grinding at Pasadena, more than four tons of glass have been removed. The disk is carried by a system of thirty-six levers inserted in the holes of the ribbed back. Both the method of support and the structure of the mirror are new in this instrument. The supporting system must operate so perfectly that no bending of the reflecting surface beyond one or two millionths of an inch will occur as the telescope moves. As the surface of the mirror was brought by polishing close to a spherical form it became clear that the disk, when tipped from the grinding table to a vertical position for optical test, sagged slightly under gravity. This sag has now been eliminated by installing a system of twenty-four squeeze levers, operated by counter weights, distributed around the rim of the glass. The spherical surface required has nearly been reached, after which it will be changed to a paraboloid by deepening the centre concavity five thousandths of an inch.

Dr. Mason stated that it is doubtful whether the new instrument will be useful for photographing moon or planets, due to shakiness of the air, which destroys detail. Instead it will be used to study faint and distant galaxies, and to analyse in high detail light from the stars and planets.

Dr. John Strong, also of the California Institute of Technology, stated that one of the uses of the 200-in.

telescope will be to study planetary radiations. Planets not only reflect visible light which they receive from the sun; they absorb and then re-radiate considerable quantities of solar energy, largely in the form of the invisible infra-red rays. The special instruments and techniques necessary for the analysis of these radiations are being developed by members of the Institute staff. Much of the information necessary for comparison of conditions on the planets with those on the earth can be obtained only by a more careful and exact study of physical processes taking place on the earth's surface and in its atmosphere. Determinations, to an entirely new order of exactness, of the effect of water vapour, carbon dioxide, ozone and the major atmospheric gases on radiation, are on the programme of research. Incidentally, Dr. Strong pointed out, data obtained in these researches will probably be of very considerable value to meteorologists as well as to astronomers.

EQUATORIAL REGIONS OF THE PACIFIC

IN his address on June 18 as president of the Pacific Division of the American Association for the Advancement of Science, Dr. H. U. Sverdrup, director of the Scripps Institution of Oceanography, stated that the Pacific Ocean is two feet higher on the Australasian side than it is on the American.

As a result of this difference in elevation, there is a narrow, relatively swift current flowing eastward along the equator. If it were not for the friction of water against water, it would move at a rate of about seven knots. Its actual rate is one or two knots. This, however, is as rapid as the current in a great many inland rivers.

The pile-up of water against the Pacific's western shore results from the action of the trade winds. Steady winds blowing across the water from the north-east in the northern hemisphere's lower latitudes, and corresponding winds from the south-east in the southern hemisphere, keep two great currents moving steadily westward in the tropical Pacific. Separating them, in the equatorial belt of calms, is the narrow return current, flowing like a river.

This narrow west-to-east equatorial current, however, accounts for only a small part of the water returned across the Pacific. Much larger streams flow away from the equator, to make the return trip at higher latitudes. In the northern hemisphere, the principal returning mass is borne in the Kuroshio or Japan current, which sweeps along the Aleutian chain and turns southward along the North American coast. It is estimated that this current carries more than five thousand times as much water as the Mississippi.

As described by Dr. Sverdrup, the Pacific is a cold monster with a relatively thin, warm skin. Surface temperatures are quite high, reaching as much as 75° F. But this warm surface layer extends downward only a few hundred feet at most. The great bulk of Pacific ocean water, in the depths, is always cold, most of it only a few degrees above freezing-point.

EXTRACTION OF GOLD FROM SEA-WATER

WITH about five million pounds worth of gold dissolved in each cubic mile of sea-water, man has often sought a way of digging out this treasure. Using electrochemical methods, comparable to those used in electroplating, gold has actually been extracted from the ocean, but unfortunately the cost of the process is five times the value of the gold obtained.

Hopes that this may be reduced to the point where gold may be profitably extracted were raised by Dr. Colin G. Fink, of Columbia University, speaking before the Wilder D. Bancroft Colloid Symposium at Cornell University.

In electroplating, the metal in the plating solution is deposited on the cathode, the negative terminal. But when an effort is made to plate the gold out of sea water in this way the metal precipitates out rapidly, and fails to collect in the solid, crystalline form in which it is desired. By using a rapidly spinning cathode in place of the stationary one, it has been found possible to get a distinctly visible gold deposit. It is the cost of providing the spinning cathode that makes the method impracticable commercially.

In his search for the reason why gold fails to deposit on the stationary cathode, Dr. Fink made the discovery that, when gold passes out of or into solution, two distinct steps are involved. Invisible dissolved gold first goes into myriads of minute particles of colloidal gold, and then later into the crystalline form of the metal. The stationary cathode fails because the metal precipitates out in colloidal form and drops away before crystallizing.

Now a problem remains, namely, conversion of the colloidal gold into the metal crystals. Perhaps it can be accomplished with high-voltage electric currents, or with bombardment of electrons. Dr. Fink intends to try these. "In any event," he said, "it is felt that, on the basis of the discovery, we have advanced one step closer to the commercial recovery of gold from sea water."

Apart from this, however, the discovery is of great theoretical significance, and has practical importance as well. For example, it may hasten development of formulæ for the electroplating of metals such as titanium and vanadium. In this way, it may have far-reaching commercial results whether the gold extraction is accomplished or not.

THE WORONORA DAM, SYDNEY

AT present four large dams serve the metropolitan area of Sydney with its water supply. The Woronora dam, which is now nearly completed, is in the Upper Nepean catchment, and serves Sydney through a separate pipeline. This will greatly increase the margin of safety against any possible failure of supply to Sydney, which has a population of nearly a million and a half. The dam is a mass concrete structure with a crest length of 1,300 ft. According to the *Commonwealth Engineer* of May 1, it will be 217 ft. high above foundation level and will impound approximately 15,800 million gallons.

After completing the excavation in the river bed, a large number of deep holes were drilled in the floor of the cut-off trench and over the remainder of the foundations. Into these holes liquid cement was pumped to seal up any cracks or fissures in the underlying rock strata. The rock surface was then made spotlessly clean by means of compressed air and water jets, after which concreting was commenced.

The impounding of about 15,800 million gallons of water by the dam across the Woronora River will result in the submergence of one thousand acres of river valley. This area, originally heavily wooded, is being cleared to prevent pollution of the water. Trees are felled, the larger ones broken up by blasting, and the undergrowth is cut down. After a short interval for drying, a running fire is allowed to pass over the area to burn off the small branches and leaves. The remaining timbers are then stacked and burnt.

An inspection gallery runs longitudinally through the dam at a height of 60 ft. above the river bed. An additional gallery is being constructed along the rock foundation to the southern abutment where excavation has revealed very broken strata. The 36-in. outlet pipes at the base of the dam are controlled at the upstream end by timber stopboards, emergency roller gates and penstocks. At the downstream end the outlets are connected to the 48-in. diameter steel delivery main which forms the Woronora pipeline, and are each controlled by a gate valve and a needle valve. A spillway channel, 30 ft. wide at the bottom and with a maximum depth of 150 ft., is being excavated through a spur to provide for the maximum flood discharge of 36,000 cusecs. This channel will be concrete built up to about flood level.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT—The Principal, Stockport College for Further Education, Stockport (August 15).

LECTURER IN MINING—The Registrar, University College, Nottingham (August 16).

HEADMASTER to re-open British School at Punta Arenas, Chile—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Chile') (August 20).

ENGLISH MASTER for the Grange School, Santiago, Chile—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Santiago') (August 20).

LECTURER IN MECHANICAL ENGINEERING at the School of Mines and Technology, Treforest—The Director of Education, County Hall, Cardiff (August 20).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Manchester 13 (August 22).

LECTURER IN ELECTRICAL ENGINEERING, and LECTURERS IN PHYSICS AND MATHEMATICS—The Registrar, Loughborough College, Loughborough (August 23).

ASSISTANT TO THE CHIEF ENGINEER—The General Manager, Manchester Ship Canal Co., Ship Canal House, Manchester 2 (endorsed 'Personal') (August 25).

DIRECTOR OF EDUCATION—The Town Clerk to the Local Education Committee, Town Hall, St. Helens, Lancs. (August 25).

CHIEF EDUCATION OFFICER—The Education Officer, The Town Hall, Chesterfield (August 26).

TEACHER (MAN OR WOMAN) WITH GOOD QUALIFICATIONS IN BIOLOGY, PHYSICS AND MATHEMATICS—The Headmaster, Dartington Hall, Totnes, Devon.

DIETITIAN—The Food Supervisor, Royal Masonic Hospital, Ravenscourt Park, London, W.6.

LECTURER IN MATHEMATICS—The Principal, Rugby College of Technology and Arts, 61 Clifton Road, Rugby.

MASTER FOR SCIENCE AND ENGINEERING SUBJECTS—The Principal, Sheerness Technical Institute and Junior Technical School, Sheerness.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Journal of the Institute of Metals. Vol. 66, 1940. Edited by N. B. Vaughan. Pp. xxxii+449+70 plates. (London: Institute of Metals.) [217

Metallurgical Abstracts (General and Non-Ferrous). Vol. 7, 1940. Edited by N. B. Vaughan. Pp. xii+652. (London: Institute of Metals.) [217

University of London. Report of the Principal on the Work of the University during the Year 1940–41. Pp. 6. (London: University of London.) [237

Mines Department. Eighteenth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1939. Pp. 34. (London: H.M. Stationery Office.) 1s. net. [237

Annual Report of Gresham's School Natural History Society, 1941. Pp. 60. (Holt: Gresham's School.) [247

Other Countries

Hokkaidō Imperial University. Calendar 1940–1941. Pp. iii+203. (Sapporo: Hokkaidō Imperial University.) [177

Imperial College of Tropical Agriculture: Department of Mycology and Bacteriology. Memoir No. 6: Notes on the Larger Fungi of Trinidad. By R. W. Rayner. Pp. 12. (Trinidad: Imperial College of Tropical Agriculture.) 1s. net. [177

Bulletin of the American Museum of Natural History. Vol. 78, Art. 1: The Mammals of Angola, Africa. By John Eric Hill and T. Donald Carter. Pp. 211+17 plates. (New York: American Museum of Natural History.) [187

The Biochemical Research Laboratories of the Franklin Institute. Pp. 92. (Newark, Del.: Franklin Institute.) [187

Proceedings of the American Philosophical Society. Vol. 84, No. 2: Commemoration of the Life and Work of Alexander Dallas Bache and Symposium on Geomagnetism, February 14–15, 1941. Pp. 119–352. (Philadelphia: American Philosophical Society.) 1.50 dollars. [187

Indian Lac Research Institute. Bulletin No. 39: Physical Chemistry of Resin Solutions, Part 1: Anomalous Solubility of Shellac and other Resins in Organic Solvents. By Santi Ranjan Palit. Pp. 8. 1 anna. Bulletin No. 40: A New Method of Preparing Hydrosols of Shellac and other Natural Resins and their Properties. By Santi Ranjan Palit. Pp. 6. 6 pies. Bulletin No. 41: Physical Chemistry of Resin Solutions, Part 2: Nature of Resin Solutions in Organic Solvents. By Santi Ranjan Palit. Pp. 8. 1 anna. Research Note No. 22: Modification of Shellac and Shellac Components with Melamine and Formaldehyde. By Y. Sankaranarayanan and H. K. Sen. Pp. 4. Research Note No. 23: Shellac-Coaltar Moulding Powders. By M. Venugopalan and H. K. Sen. Pp. 4. (Namkum: Indian Lac Research Institute.) [217

Publications of the Observatory of the University of Michigan. Vol. 8, No. 8: Spectrographic Studies of Two Semi-regular Variable Stars, W Cygni and RS Cancri. By Dean B. McLaughlin. Pp. 107–122. (Ann Arbor, Mich.: University of Michigan.) [217

Instituto Nacional de Tecnologia. O côco babacú: e o problema do combustível. Pelo S. Fróes Abreu. Segunda edição. Pp. 94. (Rio de Janeiro: Instituto Nacional de Tecnologia.) [217

The Wolf and Hirsch Hillman Building: University of the Witwatersrand, Johannesburg. A Brochure published on the Occasion of the Official Opening of the Building by the Prime Minister of the Union of South Africa, Field Marshal the Rt. Hon. J. C. Smuts, 18th June 1941. Pp. 16. (Johannesburg: University of the Witwatersrand.) [217

Bureau of Education, India. Proceedings of the Sixth Meeting of the Central Advisory Board of Education in India, held at Madras on the 11th and 12th January 1941. Pp. ii+131. (Delhi: Manager of Publications.) 14 annas; 1s. 3d. [257

Memoirs of the Geological Survey of India. Vol. 76, Water-Supply Paper No. 2, 1940: Tube-Wells in and around Calcutta. By N. C. Bose. Pp. ii+22. (Calcutta: Geological Survey of India.) 12 annas; 1s. [257

Indian Association for the Cultivation of Science. Annual Report for the Year 1940. Pp. 42. (Calcutta: Indian Association for the Advancement of Science.) [257

Annual Return of Statistics relating to Forest Administration in British India for the Year 1938–39 (with which is incorporated the Quinquennial Review ending 31st March 1939). Pp. iii+56. (Delhi: Manager of Publications.) 3 rupees; 5s. [287

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SOCIAL EDUCATION IN THE SERVICES

A GOOD deal has been said and written in recent weeks about education in the Forces, or the lack of it. It is generally agreed that something needs to be done, although there may be considerable difference of opinion as regards steps which might be taken.

Among the often conflicting evidence, particular weight must be attached to that of the men most concerned, namely those actually in the Forces. Among officers the complaint has been heard that army education is virtually non-existent, and men in the ranks have been heard to tell the same story. There are graduates in the ranks who will vouch that repeated inquiries after lectures have had no effect, and cases are even known of names having actually been collected for lectures which never materialized. Much of the complaint must, of course, be discounted as unavoidable. In addition to the static units, there are mobile units which are liable to very frequent removal about the country-side, and even the so-called static units must of necessity be moved on occasion. Removals such as these will naturally render more difficult the organization of army education, but they are scarcely an excuse for the conditions obtaining in some units.

There have been suggestions that the whole educational work of the armed forces should be organized on a compulsory basis, and recently there have been moves in this direction as regards one particular range of subjects. But in general the military authorities insist that the attendance of the men must be voluntary. Here a distinction must be made between the different types of instruction available. There are the purely training lectures, which, of course, must necessarily be compulsory. Then there are what may for convenience be termed vocational lectures, in subjects not directly connected with immediate military necessity, but likely to be of pecuniary advantage to the men on their return to civil life. Here, however, we are concerned much more with 'interest' lectures of no immediate military concern and of no likely financial advantage. Many people will be found to say that to take men away from their civil life and conscript them for military service, and then to hesitate to take an occasional hour of their free time for a lecture, is to swallow a whale and strain at a gnat. But there will be general agreement with the official view that men should not be forced to attend non-military lectures.

There is, however, among the men a considerable demand for voluntary lectures of this nature. Organizations, whose function it is to arrange lectures in different parts of the country for the civil population, report that men in uniform attend their lectures in considerable numbers,

although there is clearly not a trace of compulsion to do so. In fact, in some areas it has been known that the uniformed members of the audience have outnumbered the civilians. A major distinction exists in this respect between the three services. In general, shore naval establishments are so busy with purely instructional work that the men have neither time nor inclination for further lectures, and to a lesser degree the same is true of the Royal Air Force. But this is by no means true of the army. Vast numbers of men do not know what to do with their spare time. Granted that a certain amount of leisure is wisely spent on amusement, there still remains too much time on hand during which men would gladly be occupied. This state of affairs must inevitably lead to boredom, and one would expect it to be of major concern to the military authorities.

The main difficulty seems to be that although there is this desire among the men for lectures, the official machinery for translating the desire into the lecture does not in many cases function. Its efficiency, of course, varies much from unit to unit. Where the education officer is a man with his heart in his educational work, the possibility of organizing interest lectures will not merely be brought cursorily to the men's notice by occasional announcement or poster, but will be impressed continuously and actively upon them, and it will be emphasized that any request for a lecture will be listened to sympathetically and, where at all possible, granted. The crux of the matter is this need for the initiative to come from the ranks.

There is no doubt that a really determined seeker after enlightenment, who is prepared to persuade a few comrades to support him, can make it rather difficult for an education officer of a unit to refrain from arranging lectures. But is it fair to expect men to take such steps? And can we not readily understand if men feel that it may not react to their advantage to act in this way? Surely it should not be necessary for the provision of cultural lectures to depend upon the presence in a unit of men of rather exceptional initiative. It might be possible, for example, while retaining to the full the voluntary nature of the men's attendance, for education officers themselves to arrange attractive lectures for the men as an experiment. If as a result of experience it were found that men would not attend, other methods would have to be adopted. But all the evidence suggests that many would be glad of the opportunity of spending some of their spare time in this way.

There must be many bodies, national as well as local, which are able and willing to undertake interest lectures to the forces. On the biological side, such topics may be suggested as the human applications of biology, some of which are capable of presentation in a way directly concerned with the ideological struggle in which the men are engaged. The Nazi myth of an Aryan race of supermen, for example, could be used as a basis for anthropological lectures. Then there are all the problems of the history and development of the family, the entrancing subjects of evolution and heredity, in which there is widespread interest. On the physical and chemical side, the possibilities of dealing with applications are equally numerous, though care would of course have to be exercised to avoid making such lectures appear to be supplementary to instructional lectures at which attendance is compulsory; nevertheless, we believe that many soldiers would be quick to perceive the value of knowledge acquired by this means in their military duties. Geology should also provide good topics. A moment's consideration will show that outside the sciences also there are numerous opportunities of engaging interest. There is a far too common tendency to underestimate the intellectual level of the men in the Forces. It seems often to be assumed that so soon as a man dons khaki, he puts away all his normal mental interests and becomes a mere number. The army to-day is a fair cross-section of the younger civil population, and will have the same interests and intellectual level.

If, as is to be hoped, lectures become more easily available to the men, there will be a demand for lecturers which cannot be met from normal resources, and that will present to scientific men and others an opportunity to perform a most valuable piece of service to their fellows. There must be many who, under competent organizations, could give useful lectures; this applies with particular force to teachers, who have the vitally necessary training in presenting subjects in a simple and intelligible form. Moreover, there must be at present, in the armed forces themselves, large numbers of men who are excellently qualified to carry on this work.

It seems to be overlooked by those in authority that the present army is a body of citizens who are being trained for the purpose of defeating a specific enemy. It is not, and indeed cannot be, an army of professional soldiers. This is not meant in any disparaging sense, but solely to emphasize that the great majority of the men now serving are temporary soldiers, each of whom is looking forward to the time when, having defeated Nazism by force of arms, he can return to civilian life. He is entitled to expect that he shall be afforded opportunities of fitting himself to take his part as an earnest citizen in building up a new and better world order, and are only waiting for an opportunity to do so.

RECRUITMENT AND FOREST POLICY

AFTER seventy years of forest administration in India and Burma, and nearly forty years in some of the British Colonies, it is disturbing to realize how little the importance of the forest wealth of some of the countries in question is understood in Great Britain or by the responsible administration. The general attitude of administrators is apparently that forest property, especially great areas of tropical and semi-tropical forests, can be left to look after themselves when any period of stress, financial or otherwise, eventuates. These ideas are strongly entrenched in Government circles, particularly in London.

The present position with regard to the training of foresters is causing considerable concern. Whereas men taking certain technical degrees at universities are to complete their studies before being called up for military (or other) service, those taking a pass degree in forestry are not to be retained. This action has been taken apparently after referring solely to the Forestry Commission, which, being at present chiefly a spending department, has of necessity ceased recruiting. In reply to a recent inquiry the Ministry of Labour and National Service stated that the experience of the Central Register is that the demand for pass degree forestry men is almost non-existent. The Central Register has apparently been notified of only two vacancies for such men over the last six months, and both these were offered by the Sudan Government. The position with regard to the demand for agricultural students is of course very different.

The information thus conveyed is not even accurate. At about the time of, or slightly before, the offer of the Sudan appointments, the Punjab Government was offering two appointments for men possessing forestry degrees and was unable to obtain them. Further, the Colonial Office, though much slowed down, had not ceased recruiting. The recollection there was only too vivid, as it should be in India also, of the crucial difficulties in connexion with filling the ranks of forestry services after the War of 1914–18; and of the troubles which inevitably resulted from recruiting excessively large annual batches often inefficiently, because hurriedly, trained.

It may be asked, it being incontrovertible that the millions of the peasant agricultural populations are in one way or another dependent upon these great forest regions in the British Empire, whether ministers and their deputies responsible for the administration of these several countries really understand the position. The forest departments have been cut down, by allowing junior officers to join the Fighting Services and reducing annual recruitment. At the same time, it is well known that enhanced fellings are taking place to provide for military requirements. No forest, whatsoever its type, can stand this kind of treatment without serious deterioration. Moreover, such fellings are often, in the absence of the supervision of trained and responsible forest officers, put into the hands of uncontrolled timber contractors who have no other interest than to complete their contracts at whatever the cost in destruction to the forests.

Under the British system of Colonial administration, it is constantly reiterated that we are governing the countries in the interests of the people, and that when they are ready the government will be entrusted to them. But how are the forests being treated? What will be their condition when we make over this charge? The old Colonial policy was to give a long lease of a block or blocks of forests to a big timber company which paid a royalty, usually so much per tree felled; and it was considered that such arrangements were in the interest of the development of the Colony. Many fine forests have disappeared under this treatment—but their marketable value, that is, the money resulting, mostly left the country. Take, for example, Nigeria at the present time, and the valuable mahogany timber. Under present conditions, Government, that is, the people, obtain about £4 in royalty for a tree selling at present prices for more than £100—and much of this difference goes out of the country. Further, the forests so worked are not under the supervision of trained forest officers.

War does not stop the working of these tropical forests; it tends to enhance it. The staff requires additions, not cuts—as should be evident, if the case were rightly understood, to a wide-visioned administrator. It is not a question of planning ahead. Rather it is that of fulfilling a sacred obligation to the people we govern by handing down to their successors a better heritage; and that the present profits should be spent on the people themselves.

The Secretary of State for the Colonies recently said in the House of Lords: "Not only colonial trade but also colonial development in the widest sense will inevitably have to be regulated and controlled by Government much more than was necessary before the War." The position of forestry in the British Colonies may be commended to the personal attention of the Secretary of State.

DYNAMIC DEMOCRACY

Faith for Living

By Lewis Mumford. Pp. viii+248. (London: Martin Secker and Warburg, Ltd., 1941.) 7s. 6d. net.

WHEN President Roosevelt on September 3, 1940, in a broadcast to the United States, announced the outbreak of war, although two days later he proclaimed the neutrality of the United States, unlike President Wilson in 1914 he said that he could not enjoin neutrality of thought. The contrast is significant. Anglo-American co-operation has two aspects. There is first the community of ideals, of tradition and of thought. This is itself the firm basis for the second aspect—the practical measures of co-operation, the evolution of technical methods and of common policy in the face of a challenge to these common ideals and traditions, hammered out in part, at least, on the anvil of war.

The pace at which co-operation has advanced in this practical sphere from the establishment of the joint Canadian-American Defence Board in August 1940, the lease to the United States of British bases in the Caribbean and the Atlantic, the assumption by the United States in April 1941 of the responsibility for the defence of Greenland, the passage of the Lease-and-Lend Act, the Atlantic patrol, to the proclamation of an Unlimited National Emergency has tended to overshadow the first and fundamental aspect. That community of ideals and tradition has, however, been admirably illustrated and emphasized in successive speeches of President Roosevelt—for example, in those four reprinted under the title "Mr. Roosevelt Speaks" in the first of a series of pamphlets, "America Faces the War", issued by the Oxford University Press. They are equally displayed in the speeches of the late Lord Lothian, of Lord Halifax, of Mr. J. G. Winant, and notably in Mr. Eden's speech of May 29.

Mr. Eden's speech no less than Mr. Winant's notable address to the English-Speaking Union on May 14 reflected the depth of those common ideals and the firmness of the common resolve to defend them and to ensure that the four freedoms of which Mr. Roosevelt has spoken should be the lot of all men and not the privilege of the few. Mr. Eden indeed, after welcoming Mr. Roosevelt's message on the freedom of the seas as the condition of the continued existence of free nations everywhere, dealt chiefly with the third of those freedoms, namely, social security or freedom from economic want, and what it would involve in the days immediately after the War.

This fresh assurance to the world that the British Commonwealth means to co-operate with the United States in the creative task that President Roosevelt has described as his main purpose gives further point to the study of American history, institutions and traditions, particularly by the rising generation in Great Britain. Without at least an understanding of the American tradition, even scientific collaboration between the two countries—the pooling of information, the development of joint activities and the exchange of students and research workers, described by Prof. A. V. Hill in a recent article in *The Times*—cannot attain its full effect. A determined effort in this field is an essential for the fruition of the conception of American partnership with the British Empire in world leadership, of which the twentieth century has seen the birth.

Mr. Mumford's book now under notice is a valuable contribution to such a mutual understanding. Written in the United States and addressed exclusively to his own countrymen, as the author points out in a preface to the English edition, the first response has come from the British people. In the searching test of the summer and autumn of 1940, they set an example of what free men throughout the world must demand of themselves if any life worth living is to survive. Mr. Mumford's book throws a vivid light on the ideals and faith on which Anglo-American co-operation is based. It is a summons to realistic thinking and a challenge to action, rather than a statement of a creed or a faith upon which he insists all courageous and noble living must be based.

The moral cement that held democratic Western society together had practically disappeared by 1930, largely because the twentieth century inherited a morality for which it had never worked, which it had never examined or assimilated and which, accordingly, it was incapable of reproducing in fresh forms. This is, in Mr. Mumford's view, the fundamental cause of the drift, inertia and despair which have given Nazism its opportunity. That faith can only be countered effectively by one as strong and passionate, equally capable of fostering devotion and loyalty, and commanding sacrifice.

Mr. Mumford fully recognizes the role of reason and the significant contribution of science to human personality itself as the most effective method man has discovered for securing agreement in areas

where rational demonstration is possible. But he sees, too, how failure to take account of the material and spiritual needs of man has now endangered the world-wide co-operation upon which the growth of science, technical development and industrial wealth depends, and he writes scathingly of those who are blind to the values of truth, justice, freedom and love, which are the basis of society, and who can see only the destructiveness of war.

Mr. Mumford's searching scrutiny of the failure of the Churches is not unfair or unsympathetic to the values they represent, but he insists on the necessity for a central core of purpose, for a re-birth of the positive values of life, for a new and passionate loyalty to the spirit which gave the Churches their power, and the capacity for sacrifice which gives power to life. Searching for a new faith for living, Mr. Mumford does not indeed give us much more than this. His vision is wide and he sees life steadfastly and as a whole. He urges a return to a true regional, family and personal life and an economy of sacrifice instead of comfort. He indicates the opportunities which are ours, rather than points the way to a new faith. But his passionate sincerity makes his book as vital as his keen analysis and constructive thought. Like the Hebrew prophets, he mingles stern warning with a call to high endeavour, and the sanity and balance of the book should give it particular appeal to the many scientific workers who are already bending their efforts to the forging of firm links between the Anglo-Saxon democracies in their resistance to the gravest threat which the world has yet known to man's spiritual, moral and cultural heritage. Upon the response to that challenge may well depend the success of Anglo-American co-operation whatever form it takes.

R. BRIGHTMAN.

CHEMISTRY IN RELATION TO MEDICINE

Chemistry and Medicine
Papers presented at the Fiftieth Anniversary of the Founding of the Medical School of the University of Minnesota.
Edited by Prof. Maurice B. Visscher. Pp. vii+296. (Minneapolis: University of Minnesota Press, 1940.) 4.50 dollars.

IN 1939 the University of Minnesota Medical School celebrated its fiftieth anniversary. The committee of the Medical Faculty which had been appointed to draw up a scientific programme appropriate to the occasion decided to invite a number of distinguished men of science to deliver lectures upon different aspects of the single theme of "Some Trends in Medical Progress with Particular Reference to Chemistry in Medicine". The publication of these lectures in a single volume under the title of "Chemistry and Medicine" should be warmly welcomed by all those in Great Britain, research workers and teachers alike, who are interested in the medical sciences, and certainly will be by those who, like the writer of the present notice, believe that our own university medical schools would fulfil their proper functions of training medical students and of carrying out original research more efficiently if something of the American attitude towards the basic sciences—particularly towards chemistry—were adopted.

In his foreword to this volume the Dean of the Medical Faculty states that "this subject was chosen not because it is more important than other fields of medicine but because it represents one of the most recently developed and more rapidly expanding aspects of medical science". The view expressed in the latter half of this statement appears to sum up very well the general attitude towards the basic sciences which is found in the leading medical schools in the United States. Doubtless there would be few in the medical schools of Britain who would challenge its essential correctness, but while the Americans have the courage of their convictions and act in accordance with them, we have not and do not. Thus we pay little more than lip-service to the importance of chemistry and physics in our medical curricula; courses are provided in these subjects that are scarcely more suitable as a preparation for the study of biochemistry and physiology than are the ones provided in our secondary schools. We are, in fact, in grave danger of forgetting that the latter subjects, which may be said with considerable justification to form the basis of modern scientific medicine, have advanced so much during recent years that they can no longer be properly understood with only a schoolboy's knowledge of chemistry and physics. Considerable reforms in our medical curricula are clearly desirable and inevitably must be instituted sooner or later. It is perhaps not too much to hope that this University of Minnesota publication may indirectly expedite the institution of these much-needed reforms by bringing home to medical faculties of British universities the realization of the extent to which they have lagged behind the Americans in their attitude towards the more scientific aspects of medicine.

The fourteen articles which the volume contains are grouped under four headings: "Progress in the Application of Physical Chemistry to Medicine", "Some Recent Investigations in Metabolism", "Some Aspects of Immunity and Chemotherapy", and "Some Approaches to the Nervous Control of the Organism". All the articles are good and are packed with information, although in some the subject-matter is presented in a much more interesting manner than in others. The ones which the present writer particularly enjoyed reading were those by Prof. J. P. Peters on "Some Reactions by which Solutes may be Differentially Concentrated by the Kidney", by Dr. M. Heidelberger on "Recent Chemical Trends in the Study of Immunity", and by Prof. W. B. Cannon on "The Argument for Chemical Mediation of Nerve Impulses".

Prof. L. E. Smith's article on "Organic Chemistry in the Pursuit of Vitamin Research" contains an excellent and comprehensive account of recent chemical work on vitamins E and K. The article is so full of 'meat', however, that one cannot help wondering whether Prof. Smith's audience did not suffer slightly from mental indigestion. Prof. R. G. Green's article on "The Biology of Animal Viruses" will be valuable as a corrective to those who have too enthusiastically embraced the view that all viruses are chemical compounds rather than living organisms in the generally accepted sense of that somewhat vague term. It is difficult, however, to pass without comment Prof. Green's statement that "Work on crystallisation has fostered the general belief that viruses are relatively simple chemical compounds". Surely proteins the molecular weights of which amount to several millions can scarcely be properly described as "relatively simple chemical compounds".

Although not all the articles in this volume can strictly be said to be chemical in outlook, they form as a whole a most striking testimony to the value and importance of the recent contributions to medical knowledge made by chemistry, and in particular by American biochemistry.

G. F. MARRIAN.

THE GROWTH OF SCIENCE

A Short History of Science to the Nineteenth Century

By Charles Singer. Pp. xiv+400. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 8*s*. 6*d*. net.

CONTEMPORARY events have given the study of the history of science a new and profound importance. It is evident that science is having cataclysmic effects on human society. The investigation of the nature and origin and possibilities of science, in addition to its advancement, has become an urgent necessity as a preliminary to any considered action for human betterment. The old antiquarian notions of the history of science have been submerged in a new living attitude to the subject, which has been forced forward by present needs.

For these reasons, the appearance of Dr. Singer's new book is particularly welcome. He has aimed at the presentation of the salient facts in the development of science from Græco-Roman times until the middle of the last century. He finds the origin of science in the struggles of early man with his environment. He instances the cave drawings of bison with arrows sticking in the heart, which record the beginnings of anatomical and physiological knowledge. The foundation of astronomy was associated with the development of agricultural societies, which require a calendar for the determination of the seasons for sowing and reaping. The very word geometry means 'earth-measurement', and the invention of numerical notation was associated with the development of commerce.

These, and many other examples, show the age of scientific activities, and how they are embedded in the evolution of man and his societies.

Dr. Singer is not satisfied with the definition of science as a body of knowledge. He remarks that history has shown repeatedly that a body of knowledge which is not in process of growth rapidly withers, and ceases to be science at all. Science must therefore be an active process. He points out that the word 'scientific' means by derivation 'knowledge-making', and no static definition of science as a body of knowledge is satisfactory.

Dr. Singer starts his history, however, with the Greeks, not because they were the first men of science, but because they were the first who were conscious of science as a distinct process. He treats the history of Græco-Roman science in four chapters. The first deals with the emergence of the idea of mental coherence in Ionia, and its development by the Pythagoreans and the

Athenians. The second contains an account of the work of Plato and Aristotle and their immediate successors, which he describes as a great adventure in search of unitary systems of thought. Then the work of the Alexandrians is analysed. The divorce of science and philosophy is noted, together with a failure of intellectual nerve.

In the Roman period, science became the handmaid of practice, and was accompanied by a general failure of intellectual inspiration. This was followed by an almost complete failure of knowledge during a whole millennium. Then there was a revival of humanism and an attempted return to the culture of antiquity. The downfall of Aristotelianism was accomplished at the start of the seventeenth century, and was accompanied by new attempts to give a synthetic description of the universe and Nature. The Newtonian mechanistic scheme and determinism were enthroned. and have endured until recently. Dr. Singer finds no change of method since the seventeenth century, but only an immense extension of scientific knowledge.

His comments on the relations between the Christian outlook and the development of science are very interesting, and are supported by excellent quotations from St. Augustine and other fathers of the Church. He discusses with unusual illumination the contributions of Syrian and Jewish scholars, and he shows how much of what passes as Arabic science was really due to them.

The stages of the change of ideas during the passage from pagan to Christian thought are most conveniently summarized in half a page. The fundamental premises of alchemy are epitomized in the same way, and there are similar summaries of Goethe's contributions to biology; Schwann's theory of the cell, Claude Bernard's conception of the internal environment, and the origins of the theory of evolution.

Dr. Singer's learning is always exact, as befits the senior British historian of science. His book is full of fascinating information, and will at once become a standard work on the history of science both for the man of science himself and the general reader.

J. G. CROWTHER.

STUDIES IN BACTERIOLOGY

General Bacteriology

By Prof. D. B. Swingle. Pp. xii+313. (London: Chapman and Hall, Ltd., 1941.) 16*s*. net.

THE method of presentation of a subject taught at every university by a writer of another nationality differs, of course, from that customary in Great Britain. It is only fair to say that the distinction may be more apparent than real, and that it is usually a question of manner, not of matter.

Prof. Swingle has a standing in his subject which transcends mere geographical boundaries. A textbook by him therefore on his own subject rightly arouses interest. He has drawn freely on his own experience in teaching and research in determining the lines on which he has drawn it up.

Micro-organisms are closely related to the whole problem of disease; they play also an important part in the manufacture of certain industrial commodities, such as dairy products and alcoholic beverages, and incidentally the curing of tobacco. The importance of these relations explains why bacteriology tends to be given a secondary place in that it is usually considered from the angle of one or other of its effects or uses. Prof. Swingle rightly prefers to present the subject as a science in itself; thus therapy alone is permitted a homogeneous and complete description. The details, helpful or otherwise, of the activities of micro-organisms in their practical aspect are by no means neglected but are given proportion corresponding to their importance.

"General Bacteriology" thus offers a systematic approach to the subject as a whole. The fundamental principles are fully covered and proper space allotted to the important aspects of classification, morphology, reproduction, growth, nutrition, relations to environment and the products of bacteria. After covering this groundwork, Prof. Swingle goes on to micro-organisms of soil, of water, air, sewage and foods, proceeding in natural sequence to discuss contamination of food, industrial micro-biology, and the relations of bacteria to disease processes, infection and immunity.

Prof. Swingle writes in a simple, straightforward style, easy and readable. The illustrations are adequate in number and in applicability. The book can be commended as a thoughtful and balanced presentation of the subject of bacteriology as a whole.

J. GEOGHEGAN.

Entomophagous Insects

By Curtis P. Clausen. (McGraw-Hill Publications in the Zoological Sciences.) Pp. x+688. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 49s.

THE last thirty years, or thereabouts, have been productive of great advance in our knowledge of entomophagous insects. This accumulated information is largely the outcome of the increasing use made of the biological method of pest control, which has stimulated investigation of both parasites and predators. Mr. Clausen is a distinguished entomologist on the staff of the U.S. Department of Agriculture. His own studies have been mainly directed to the parasitic Hymenoptera and he is well qualified to write a book of this kind.

The subject-matter is arranged under the orders and families concerned, beginning with the Hymenoptera and ending with groups of lesser importance. The author adheres closely to the limits imposed by the title of the book, and consequently little or nothing is said regarding other carnivorous insects attacking various invertebrates, birds or bats or other mammals. As it is, the book is one of very considerable dimensions for so specialized a subject, but it is a veritable mine of carefully collated information. The extraordinary adaptations to various modes of life, and the great diversity of larval forms betrayed by so many of the insects under consideration, provide unique material for a most interesting biological story.

The book is one written essentially from an entomologist's point of view, and those who consult it will find therein a great deal of information that has not previously appeared in any manual. A feature of special value is the 46-page bibliography at the end of the last chapter. The general biologist who peruses its pages will feel some disappointment in the restricted treatment of the remarkable phenomena associated with insect parasitism and their theoretical implications. Notwithstanding this limitation, the author is to be commended on having written a valuable and, in some ways, unique volume. It is to be regretted, however, that it has been found necessary to price this work at so high a figure, thus placing it out of reach of many of the younger potential purchasers. A.D.I.

The West Highlands and the Hebrides

A Geologist's Guide for Amateurs. By Alfred Harker. Pp. xxiii+128. (Cambridge: At the University Press, 1941.) 8s. 6d. net.

THE West Highlands and Islands had a warm admirer in Alfred Harker, and it is therefore not surprising that he had long contemplated the writing of a book by which he might share his knowledge of the region. Unfortunately, Harker died before his project was fully completed, but with the help of others the book is now published in homage to his memory. A pathetic interest is attached to the biographical sketch of Harker contributed by Sir Albert Seward; it was written shortly before his own death.

Harker's plan was to describe the region in terms which would appeal to travellers and others interested in geology and scenery. This has been accomplished in chapters arranged as a series of excursions, and his description of the richly varied character of its rock formations will prove useful to geologists and geographers alike. The volume is profusely illustrated by simple but effective outline sketches drawn by the author, and these have been augmented by the inclusion of geological and topographical maps. An excellent glossary meets the needs of the layman unfamiliar with the names of rocks and minerals.

There is little room for criticism; but the editor's omission of Kimmeridge rocks in the table of strata may be noted and, like the reference to the Permian, a footnote might have been inserted to explain that the greater part of the Durness Limestone is of Ordovician age.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1940. Edited by Dr. M. Epstein. Pp. xiv+478. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 35s. net.

SINCE 1758 the Annual Register has not failed to make its yearly appearance. The current volume maintains all the established traditions of the series. More than half the volume is occupied with the history of the year, first and in most detail British and Imperial, and then foreign history. For 1940 these chapters are virtually a history of the War and of Nazi intrigue. The story is told objectively. The remainder of the volume has the usual summary reviews of literature, art, finance and law, and obituaries of distinguished men and women. The public documents, printed in full, include notes regarding United States destroyers and naval and air facilities for the United States in British trans-atlantic territories; Memorandum of Agreement with General de Gaulle regarding French Forces; the Three-Power Pact of Germany, Italy and Japan; and the Norwegian Government's White Paper of April 1940 on German Aggression in Norway.

British Museum (Natural History). Instructions for Collectors No. 4A: Insects

Compiled by Dr. John Smart, with the assistance of other Members of the Staff of the Department of Entomology. Pp. vi+164. (London: British Museum [Natural History], 1940.) 1s. 6d.

THIS little manual is a great improvement on its predecessor and, for its very modest cost, provides practically all the information likely to be wanted for collecting and preserving insects. A useful addition is the well-illustrated section dealing with how to recognize the main groups of insects, when to collect and how to collect. The book should do much to aid potential and other collectors in obtaining material of scientific value and preserving it in a manner enabling the best use to be made of it. It can be highly recommended also to university and college students and to school natural history societies.

SCIENCE AND FAITH

SIR WILLIAM BRAGG's Riddell Memorial Lecture on "Science and Faith", delivered before the University of Durham at King's College, Newcastle-upon-Tyne, on March 7, which has now been published*, will interest all who wish for harmony between the different spheres of human thought.

The 'natural knowledge' which has grown so amazingly in the last three centuries is not so distinct in character from other knowledge that it is to be considered entirely by itself.

"The whole knowledge at our disposal is far greater than our modern science, as the whole is greater than the part. It includes the observations of countless generations of men, their experiences of life and the record of their thoughts thereon and the comments of their interpreters and lawgivers, the histories of the actions of nations and individuals especially in relation to the faiths on which they have acted, all in fact that men have learnt since they first began to learn."

Modern science is only a part of this mass of knowledge. If it is a new chapter in our book of knowledge, does it throw light on the chapters that have gone before? Is it going to help men towards a solution of the great problem of the choice of an attitude to life? Men have adhered to certain faiths: does science affect their present choice of a faith? Such are the questions raised by Sir William Bragg in his lecture.

"I would describe Science", writes Sir William, "as a collection of observations of Nature. There is an old word 'observables' which aptly describes the facts that the scientist is on the look-out for. Science observes the observables, tries to see what is noteworthy and records it. Gradually a mass of knowledge is accumulated which is sufficiently stable and reliable, so that it is worthy of study and can be used safely."

The man of science as he works must draw temporary conclusions from what he sees because in so doing he finds guidance in the next effort of discovery. If he made no attempt to plan his work he would lose himself in a mass of uncoordinated facts; hence he must try to find correlations, rules and laws. To grasp what he has already got would be impossible unless he did this.

"He therefore makes hypotheses. But it is to be observed that all such hypotheses are tentative, and are to be amended constantly as knowledge grows. There is no finality in these attempts to draw conclusions. Some are more enduring than others, but it can never be said of any law formed and used by the scientist that it is good for all time."

Sir William Bragg supplies three notable instances of universally accepted and to all appearance permanently secure hypotheses which in due course had to be revised in view of new knowledge. Such were the atomic theory of matter and the Newtonian theory of gravitation. Yet in neither case, Sir William points out, was the work of those who formed the superseded theory wasted or wholly invalidated. Chemists can still work with the atomic theory, knowing that the chances of any atom breaking down while in their hands are so small as to be negligible. And though Einstein has shown that there is a point beyond which Newton's theory begins to lack perfection, the astronomer's work is not affected.

The third instance of a scientific theory which had to be modified is a fine example of this need to abstain from dogmatism, which science teaches continuously. In his "History of the Inductive Sciences" Whewell spoke of the undulatory theory of light as the perfect example of a true and complete theory since it not only explained all that was known but also continually predicted new phenomena which were then found to exist.

"Yet there came a sudden end to this certainty when the properties of X-rays were made plain, and it became certain that they and light itself had corpuscular as well as undulatory properties. When, however, the work of the long years of development of the wave theory was reconsidered, it was found to be still well done and without flaw: the light really was a wave motion. Yet the new discoveries cannot be readily explained on any but a corpuscular hypothesis.

"Here then is a case where not only was the accepted and trusted theory in need of modification, but there is the added complexity that two hypotheses which are both supported by quantities of excellent proof seem to be mutually exclusive. There is as yet no simple explanation, in the sense that no clue has been found which would lead simply from one hypothesis to the other. A mathematical formula can be found which covers the two cases, and that is all."

There is thus a position "which seems nonsensical and is nevertheless true". This surely is a test case of science's dislike of dogmatism.

* Science and Faith. By Sir William Bragg. (University of Durham: Riddell Memorial Lectures, Thirteenth Series, delivered before the University of Durham at King's College, Newcastle-upon-Tyne, on March 7, 1941.) Pp. 24. (London: Oxford University Press, 1941.) 1s. 6d. net.

Passing on to the other side of his subject, Sir William Bragg accepts the definition of faith found in Hebrews xi, 1, that it is "the substance of things hoped for, the evidence of things not seen", which he calls "an unforgettable sentence obviously full of earnestness and meaning". The Greek would appear to convey the meaning that faith consists in regarding as already actual, things which are only as yet hoped for, and in an assurance that things not yet seen are nevertheless real. The writer of Hebrews supplies a number of instances of persons who "died in faith", that is, lived until death without surrendering this attitude of mind and will. Thus Sir William's interpretation of the sentence is sound, namely, that the writer's faith, "the faith which he held himself and preached to others, was a hypothesis so firmly held and trusted that he would and did stake his life upon it".

Hypothesis is therefore integral alike to science and to faith, and so forms a link between the two, and this is being more generally recognized on both sides.

"It seems to me that in recent years the way of the scientist and the way of the seeker for a good way of life have come to have more features in common than in the past, more than is generally recognized. If the scientist was ever unduly dogmatic he has ceased to be so: this one-time self-assertion at a time within living memory was in no small degree a weapon of offence and defence which he felt himself compelled to assume. In part it was a mistake of his own making. I should think that the theologian's dogma is now becoming more and more like the scientist's hypothesis, so probable of course that he accepts it and acts upon it always. If the theologian says that I am not justified in my statement, I shall still suspect that the disagreement is subject to a misunderstanding."

His point that hypothesis is of the essence of science and faith alike is of such importance that perhaps it deserves to be examined more closely than the limits on his space enabled Sir William Bragg to do. Are the two hypotheses, that of science and that of faith, the same in kind, or is a radical distinction to be drawn between them? The scientific hypothesis can be proved or disproved here and now by referring the matter to a controlled experiment; the appeal is to sense-experience and to 'facts'. But that the religious hypothesis cannot always be so proved is indicated by what the writer of Hebrews says of his exemplars of religious faith, "These all died in faith, *not having received the promises*". These people, some of whom he says died in torments, never received confirmation of their faith—at least not in this world. Even the last recorded words of the Founder of Christianity were "My God, my God, why hast thou forsaken me?"

It is, of course, true that the Christian 'way of life' can be tested in practice as to whether or no it 'works'. This is clearly what Sir William Bragg has in mind when he writes:

"Science is experimental, moving forward step by step, making trial and learning through success and failure. Is not this also the way of religion, and especially of the Christian religion? The writings of those who preach that religion have from the very beginning insisted that it is to be proved by experience. If a man is drawn towards honour and courage and endurance, justice, mercy, and charity, let him follow the way of Christ and find out for himself that it leads where he would go. No findings of science hinder him in that way, nor do they give any direct proof that it is the right one to follow."

Of course a pragmatic test of this sort must not be pressed to carry a weight of proof of which it is incapable. It can never establish the Christian religion as a body of principles with metaphysical validity. But is such a thing necessary? Science can dispense with metaphysics, so why not religion? But *can* science dispense with metaphysics altogether? Are there not involved certain "absolute presuppositions", as Prof. R. G. Collingwood calls them, which are of a metaphysical nature, and without which science could not stir an inch? For example, the idea of the uniformity of Nature, the conception of the rationality of things, and the idea of causation itself? Hume long ago claimed to have shown that the validity of the causal relation is not founded in experience, since experience only shows us that one event follows another, and does not exhibit to us the inner necessity of their union. In short, the idea of causation is a hypothesis, rather different from the type of hypothesis illustrated by Sir William Bragg, since science cannot afford to change it, but perhaps not dissimilar from the type of hypothesis, or "absolute presupposition", which religion seems to need.

Of course the man of science is quite justified in taking the idea of causation and other similar ideas for granted; if he did not, his researches into natural happenings would never begin, still less arrive anywhere. And perhaps the mistake the exponents of religion make is not in having metaphysical doctrines, but in placing them on the threshold of religion, where they often prove an obstacle to people trying to enter the house. It may be that Sir William Bragg has this kind of obstacle in mind when he says towards the close of his lecture:

"I am not sufficiently informed to know how all types of mind are affected by the demand for the

absolute acceptance of definite items of faith as a preliminary condition to progress. I believe I can safely say that to many minds this is an impossible demand. Conviction of the truth of any faith, so far as a man can measure the truth, is to be gained by practice, and it is here that the scientist finds an illustration in his own work. Every man, in the circle in which he finds himself, it may be a small circle, his means may be small also, can try the Christian way, and discover for himself and acquire his own convictions. He tests his faith. He has ever in front of him the hope that he will by doing his service play his part in binding the community together."

Speaking of his own youth, Sir William writes: "What we boys asked was the meaning of the word 'believe' when it so often laid down a condition which must be satisfied before a man could be 'saved'. '. . . they that have done evil into everlasting fire. This is the Catholick Faith: which except a man believe faithfully he cannot be saved'. Had we passed the test, or had we not? We were terrified by the threatened consequences. To the youth daily instructed in the need for accuracy and the careful interpretation of words, this was indeed a dreadful saying. If anyone took them at their face value, drew them towards him and explored their significance he would necessarily be driven mad, unless indeed he was deprived of feeling by some drug."

It is a pity that the zeal of the theologian should have converted his "absolute presuppositions" into a barbed-wire entanglement menacing the pilgrim who would explore his temple.

PSYCHOLOGICAL EFFECTS OF AIR RAIDS

By Dr. Robert H. Thouless

University of Cambridge

The experiences of war through which Great Britain is passing pose many psychological problems of urgent practical importance. Knowledge has been gained in many directions which can now be put to practical use. Detailed studies of evacuation, such as the Cambridge Evacuation Survey, the findings of which have recently been published*, enable us to assess both the general success of the evacuation policy and the particular steps which must be taken to avoid failure in special cases. The problems of shelter life have been studied by medical men, by psychiatrists, by shelter lecturers, and by psychologists who have lived in shelters because they have been bombed out of their homes, and it is now possible to gain some idea of the intricate social psychological problems of shelter life. The effects on morale of air-raid experiences have been studied both by academic psychologists and by mass observation, and it is to be hoped that their findings may be made use of by those Government departments responsible for civil morale. These problems were considered at a discussion of the problems of air-raid shelters, evacuation and the effects of air raids at a general meeting of the British Psychological Society on July 26.

Psychologists and psychotherapists have approached the problem of shelter conditions from many different angles; the problems for future research have been clarified and some knowledge has been gained which can be made the basis for practical proposals. The transfer of authority attitudes from within the family to the officials of shelter groups (shelter marshals, etc.) was suggested as an important factor in determining whether defence mechanisms against raid shock would be adequate. It was noticed that a greater sense of security was given by underground shelters than by surface shelters and that the presence of crowds and of the various shelter officials also reduced anxiety. For both of these reasons, individual Anderson shelters were generally neglected and communal underground shelters were preferred. Of those who went to communal shelters, 95 per cent were reported to have got adequate sleep; weight lost at home was regained and neurotic symptoms disappeared. It seems clear, therefore, that the provision of communal shelters rather than of individual ones is, in general, the best policy.

Studies of those who went through air raids as children in the War of 1914–18 showed the importance of adult attitudes of mental calm as a means of protecting children against raid anxiety, and also the reduction of fear by the provision of suitable spontaneous activities. While lectures on such subjects as first aid have been provided for adults and adolescents in some areas,

* The Cambridge Evacuation Survey. Edited by Dr. Susan Isaacs. Pp. ix+236. (London: Methuen and Co., Ltd., 1941.) 8s. 6d. net.

it may be suggested that more effort should be made by those responsible for shelter policy to provide apparatus for suitable activities generally and particularly for children. One area was described in which shelter provision was very inadequate when raids started and a generally apathetic and inert attitude was found among the shelterers. There was little activity ; some knitted, few read. Co-operative activity under a leader did not generally develop spontaneously ; but when a suitable leader was chosen, the amenities of the shelter were greatly improved by co-operative effort. In one shelter, the selection of a good leader resulted in Oxo service, lectures and Christmas decorations, whereas there had previously not been even a broom to sweep the shelter clean.

The problem of the evacuation of children less than five years of age was one that aroused great interest and keen discussion. The general undesirability of evacuating children of this age without their mothers was recognized. On the other hand, it was pointed out that mothers of young children are now often doing war work and that the choice might be between adequate care away from the mother and neglect at home. It was also mentioned that experience at hostels for young children has shown that many of those evacuated from badly bombed areas show neurotic symptoms and unsatisfactory relations with their mothers, and that a period of separation from their mothers in a hostel produces marked improvement in both respects. Some of those present at the meeting consider that a foster-home is more suitable for a young child than a hostel if separation from the mother is necessary or desirable. Other solutions of the problem were mentioned. The Society of Friends has hostels for young children accompanied by their mothers, but these experience the difficulties that have been found in all plans for evacuation of mothers. The mothers do not wish to desert their husbands. A plan that was reported to have been very successful where it has been tried is the provision of nursery centres where children can be left while their mothers are at work. The children may be anxious at first, fearing that their mothers will not return to fetch them in the evenings, but when the experience of a few days proves that this fear is unfounded the children become very happy and contented in the centres. As an alternative to evacuation, this plan suffers obviously from the disadvantage that it may mean that young children remain in danger areas exposed to the risk of physical injury and that this risk must be balanced against the danger of mental injury through separation from the mother.

The general feeling of the meeting seemed to be that evacuation of the mother and young child together is the ideal solution, but that since circumstances might make this impracticable and even in some cases undesirable, psychologists should be prepared to advise alternative methods in particular cases.

One of the defects of the original arrangements for evacuation found in many districts was the lack of provision for those children whose behaviour problems are such as to make them an intolerable burden to the ordinary householder. In many places hostels are provided for such children, but many of these hostels were and still are by no means suitable for this purpose. Some of those present described bad hostels, unsuitably equipped and staffed, where the staff have no idea whatever of the problem child's difficulties or how these might be treated, and where the incidence of certain problems (such as enuresis) is made unnecessarily high by unsympathetic treatment. One speaker described an ideal hostel for treatment at Aylesbury which is housed, equipped, staffed and managed with the aim of relieving the problem child of the burden of his problems. Elsewhere psychological clinics have done excellent work among problem children although the combination of clinic with hostel for treatment appears to be the ideal where practicable.

It is generally felt that a satisfactory hostel is one which makes provision for treatment and is not merely a dumping ground for problem children. There is, no doubt, also a place for the hostel which is merely a clearing house for children who have billeting difficulties, but billeting in such a hostel should be regarded as only a preliminary to treatment. It is felt that psychologists are now in a position to state the requirements of a treatment hostel in equipment and staff, and it was agreed at the meeting that such a statement should be made.

It is not unlikely that the ideal requirements of the social psychologist in provision for problem children will not be met on grounds of expense. It must be remembered, however, that we now have unique opportunities of dealing with the problems of maladjusted children at an early stage and that the provision of reformatories and prisons for the maladjusted members of the community is also a heavy expense to the community.

Investigations in heavily raided areas other than London seem to show that, although morale was in general good, there were failures of morale and a definite tendency for it to deteriorate, particularly in areas which had a number of heavy raids with long periods of calm between them. Deterioration of morale was shown by unauthorized and unnecessary evacuation, general depression about the War, and criticism of the Government. It was interesting to notice that while people in the most

heavily raided areas were more critical and depressed, they were nevertheless more active in A.R.P. work and saved more money than in less raided areas. They were also more inclined to reject the idea that we should undertake reprisal raids on German towns.

The necessity was pointed out of confidence (and justified confidence) in the shelter provided. In some areas shelters have been unsafe, with bad psychological effects. The possibility was pointed out that even where there are no dramatic failures to stand up to bombing (such as psychoneuroses), there might be long-term effects which were little noticed at the time, and that morale might become worse during this winter. It is necessary that there should be propaganda directed towards the strengthening of morale and that psychologists should play a part in the development of a morale policy.

One possible effect of war conditions which has aroused some concern is their influence on the education of children. It is disturbing to learn that, in Glasgow, achievement tests showed that, in one subject (reading), children were on the average about one year behind mean school level. It is also suggested that the situation may be worse in areas which have been raided over a longer period than Glasgow. On the other hand, there must be a considerable proportion of children in reception areas whose education has been relatively little retarded. It seems very desirable that there should be more extensive studies directed towards discovering the amount of educational retardation in different areas and the proportion of children showing marked educational retardation, and if this is found to be generally serious that steps should be taken to prevent the matter from becoming worse. Many of the advantages of universal education and the additional advantages hoped for through a raising of the school-leaving age will be lost if there is continued educational retardation through enemy action.

SOLID CARBON DIOXIDE AS AN EXCITER OF VIBRATIONS

By Mary D. Waller
London (R.F.H.) School of Medicine for Women

It is well known that solid carbon dioxide produces noises or squeaks when it is brought into contact with metal objects such as a hammer or chisel, and so long ago as 1932 the fact that a bicycle bell could be made to emit a chattering ring by touching it with the material was brought to my notice by an itinerant vendor of ice-creams[1]. This strange phenomenon has since been investigated very thoroughly and the results published in a number of papers[2]. As the solid carbon dioxide method of producing vibrations is in certain respects unique and can be applied to various problems, it seems desirable that a short account of it should be put on record.

Production and Maintenance of Pure Loud Tones

When a tuning-fork of ordinary pitch is touched with solid carbon dioxide, a chattering noise is produced. When glass is touched there is no sound. When, however, a fork of say 2000–3000 c./sec. is tried, provided the contact between the two solids is light and the area of contact small, an intense pure note may be produced and maintained for several minutes. The demonstration of this phenomenon is very striking.

Quality of the Exciter. Compressed 'snow' solid carbon dioxide is not satisfactory. A high density 'ice' variety, such as 'Drikold', which is manufactured by Imperial Chemical Industries, Ltd., may be recommended. The material may be conveniently stored for some days in a large thermos flask, and handled with lined gloves or a piece of flannel or tweezers. It may be broken up, so as to obtain suitable pointed pieces, by means of a hammer and chisel.

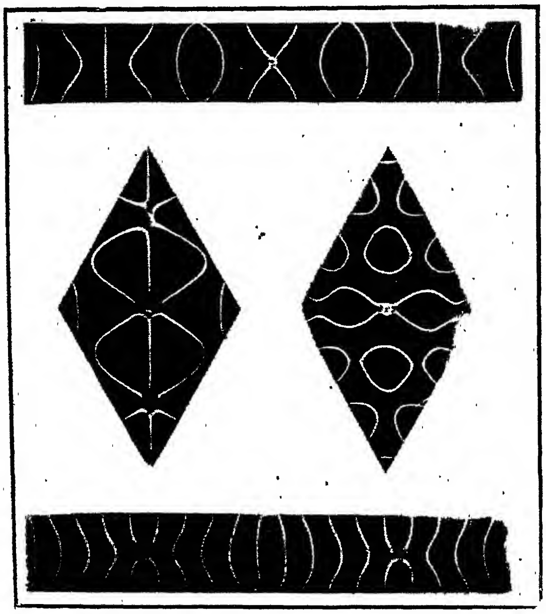
Nature of the Vibrating Object. Tuning-forks, suspended brass bars, tubes, rings and metal plates are easily set into vibration, since they are good thermal conductors and possess adequate vibrating properties (see also below).

External Conditions. The atmosphere must be dry. Excitation may be rendered independent of the hygroscopic conditions by gently warming the vibrating object and surrounding air by means of a bowl electric radiator, care being taken that the heat is not sufficient to alter either the elastic or damping properties of the material of the object.

Manipulation. It is very important that the

pressure between the two solids be very light and the area of contact small, and it is desirable generally to use pointed pieces of solid carbon dioxide. It does not appear possible to substitute a mechanical device for the hand, and the skill of the operator in sensing the onset of vibration, the amplitude of which grows with remarkable rapidity, increases with practice.

The range of frequencies most easily excited by means of solid carbon dioxide lies between about 1000 and 4000 c./sec. and depends but little upon the size, shape, mass, or material of the vibrating object. When objects of low fundamental frequency are touched with solid carbon dioxide, as mentioned above, a rattling noise may be produced,



CHLADNI FIGURES PRODUCED BY SOLID CARBON DIOXIDE

but when the technique described in the last paragraph is adhered to carefully, it becomes possible to excite the overtones which lie in the preferred range of 1000–4000 c./sec.

Mechanism of Production of Vibrations

Solid carbon dioxide sublimes at $-80°$ C. Large pressures are accordingly produced when the material is brought into contact with the warmer metal, due to the formation of gas. The source of energy is the heat which is transferred from the one solid to the other, and the phenomenon may be compared with the Trevelyan rocker, where, however, the vibrations are gravitational, not elastic, and are sometimes slow enough to become visible. The vibrating object, of course, governs the frequency of vibration, and each time the object approaches the exciter it receives an impulse due to the irresistible molecular forces of sublimation which are operative at the moment of contact. Each impulse lasts only a fraction of the total period, when the localized pressure is then very great as compared with that which exists during the rest of the vibration. It is also possible to offer an explanation, in terms of the mean free path of the carbon dioxide molecule, of why the solid carbon dioxide is selective in the matter of the range of frequencies which it will excite[2].

Vibrating Plates

One of the most interesting applications of the solid carbon dioxide method of producing vibrations is to the production of Chladni figures on plates. A few illustrations of the possibilities of the method are given in the accompanying figures and the reader will find numerous others in the papers[3,4], in which the systematic study of vibrating plates of several different shapes are described.

Excitation is very intense and the fact that it can be effected at any point on the surface, and that mechanical pressure (other than that of the gas) is absent makes the method peculiarly simple and effective. Moreover, since the exciter possesses no natural period of its own, no adjustments of frequencies are necessary as in the case of excitation by electrical methods, and the possibility of producing forced vibrations is also excluded. When a divider is used judiciously to fix the position of the nodal lines, any normal figure may be rapidly produced at will. It has been possible, for example, to produce every single one of the fifty-one normal nodal figures of the first six octaves of the free circular plate and to arrange their photographs in a systematic manner on a single diagram. The nodal designs of the square plate have been treated in a similar manner and also those of the right-angled triangular plate[3].

Further Applications

Some of the nodal designs, especially when two normal modes of near period combine, are very beautiful and have been used for decorative designs executed in metal or wood and for embroideries.

Want of uniformity or flaws in plates may be discovered by the distortions in the normal nodal figures which result therefrom. Semi-conductors may be distinguished from insulators, a matter which is of some interest to the geologist. I have actually used the method successfully to find, at short notice, a long-lost quartz lens which had been placed among a large number of glass lenses. Similarly, diamonds and pearls may at once be distinguished from their counterfeits, inasmuch

as the real articles emit a rattle or squeak when touched with solid carbon dioxide.

It is also noteworthy that the object to be excited need not be rigidly supported. Another characteristic is the picking out of single overtones in objects of irregular shape which emit but a jangle of notes when struck with a hammer. This might be applied to find the resonances in either small pieces of machinery or in small-scale models of larger machines.

Finally, looking to the future, it is worth recording that the demonstration of the production of Chladni figures by means of solid carbon dioxide is an excellent subject for scientific television[5] since, while the patterns grow on the screen, the corresponding note is heard by the ear. The success of the demonstration is assured by the dry, warm conditions which necessarily prevail under the fierce illumination necessary for the projection.

[1] NATURE, 135, 475 (1935).
[2] *Proc. Phys. Soc.*, 45, 101 (1933); 46, 116 (1934); 49, 522 (1937).
[3] *Proc. Phys. Soc.*, 50, 70 (1938); 51, 831 (1939); 52, 452 (1940); 53, 35 (1941).
[4] NATURE, 143, 27 (1939).
[5] *The Listener*, 527 (1938).

CENTENARY OF W. H. HUDSON

BY H. J. MASSINGHAM

W. H. HUDSON, the centenary of whose birth is celebrated this month (see NATURE of August 9, p. 160), was unique as an interpreter of Nature, and that is perhaps the reason why he has had neither followers nor predecessors. The school of modern ornithology and natural history acknowledges no debt to Hudson; its highly specialized activities would, indeed, have been abhorrent to a naturalist who wrote "To specialize is to lose your soul". Its prophets and teachers have been Edmund Selous, Eliot Howard and the biologists, not Hudson. Nor is it possible to trace any line of descent or genealogical tree between him and such great or less dynamic names as John Evelyn, Gilbert White, Dorothy Wordsworth, Edward Jesse, Thomas Miller, Charles Watterton, Frank Buckland, Richard Jefferies, and others, all of whom are to be gathered from the 'herbarium' of the English rural tradition. If we prospect English writers who have immortalized foreign scenes like Bates, Darwin, Wallace, Belt and their kin, we shall find only a superficial resemblance between their works and the Hudsonian corpus of exotic reminiscence like "Far Away and Long Ago", "Idle Days in Patagonia", "The Purple Land", "El Ombu" and "The Naturalist in La Plata". The only exception to so general a statement is perhaps "Argentine Ornithology", written avowedly as a text-book and in conjunction with W. C. Sclater, a professed man of science. But even in this work Hudson is plainly cramped and ill at ease, while his descriptions are constantly flooding the scientific banks of classification and the presentation of strictly relevant data.

On the other hand, the problem of assessing Hudson's place in science or letters or both or neither is by no means solved by assuming, as his fellow and contemporary observers of Nature were inclined to do, that he was first an artist and only secondarily a naturalist. This was an error of the first magnitude. Hudson's contributions to our knowledge of South American fauna and flora were both extensive and profound. To say nothing of his intimate studies of Argentine and Patagonian birds, particularly in courtship, migration, social habits and melody, his masterly discoveries into the living characteristics of such pampa or desert animals as puma, vizcacha, huanaco, dolichotis, semi-domesticated cattle and horses (not to mention the feral Indian and gauchos) alone entitle him to take his place among the chieftains in the hierarchy of natural observation. His original records of English wild life were of scarcely less permanent value and novelty. Instances are numerous—I need only refer to his accounts of *Locusta viridissima* in "Hampshire Days", of such rare species as the Dartford and marsh warblers, of the continued mating of starlings after the breeding season in "Birds in a Village", of the behaviour of shepherds' dogs in "A Shepherd's Life", of the perceptual senses of deer in "A Hind in Richmond Park", to his criticisms of Darwin's theory of sexual selection, and there are at least a score of further examples which reveal Hudson as a pioneer in the investigation of natural phenomena alone.

Yet it is obvious that to claim Hudson for the remembrance of posterity upon no other ground than this is to compass only a fragment of the man. Hudson was essentially a mysterious and paradoxical figure, and this central truth about him gave much handle to misunderstanding both among men of science and the general public. The latter realized his greatness so little as to ignore his enrichment both of science and literature for the first thirty years of his English life after leaving the Argentine. He was compelled to live in London (in the

dingier part of Bayswater) because he could not afford to escape from it into his natural environment, which was the country, and the wilder the better. He was not recognized as of any deep significance in authorship until he was an old man, and then, as he told me himself more than once, when fame and the less straitened means that accrued from it were of little account to him. To the learned he was suspect because he mixed up natural history with religion, poetry, animism, fancy, emotion and the humanities. He would not fit in to the current definition of the arts because of his naturalism and his crusading spirit or into that of scientific analysis because such elements as vision and fantasy were considered irrelevant to it. That is the trouble of being something unique : escaping all the categories, it earns either their hostility or indifference. And it must be confessed that it is difficult to come to terms with a man who is neither one thing nor the other, but both in one, a oneness that is specifically neither.

Nevertheless, I think it is possible to arrive at a true conception of this enigmatic spirit, though without dispelling a certain mystery that clothes him and is part of the mystery of life itself. But only on one condition. It is that we should regard him not as standing apart from Nature and examining its manifestations in the detachment of subject from object, but as a being living and speaking within Nature and in an organic relation with Nature extremely difficult for modern man to comprehend. Withdrawal from Nature is the attitude of modernism, and distance in this instance lends not enchantment but diminution to the view. By looking at Hudson as a kind of human embodiment out of Nature, we are not only enabled to see him more clearly and to resolve the apparent contradictions and antitheses in his make-up, but also to enlarge our own perception of Nature itself, or, as Hudson would undoubtedly have said, of Nature herself.

The most remarkable quality of Hudson as a writer was his articulate primitiveness. This went very deep, and was by no means confined to his habitual and entirely unsophisticated preference for the wildness in Nature. He wrote, if I may be pardoned the apparent antimony, as a richly cultivated wild man, and to an extraordinary degree he shared certain characteristics of primitive man which in the most natural way he embodied into his writings. The animistic tendency is one, closely allied with the mythopœic and with story-telling. Hudson could scarcely write a page without bringing some tale into it, tales not only of fact but also of invention, not only of the concrete, but also of the fantastic, and the curious thing is that his reader is not in the least jolted by their seeming incompatibility. Myth and actuality were strangely blended, and his anthropomorphic bent (heinous to the scientific mentality !) was just as 'real' in him as were his chronicles of animals or peoples, whose bona fides nobody would think of doubting.

Yet in other aspects Hudson was a good deal more modern than the moderns. His vision of Nature—and we are bound to speak of it as such—was consciously pantheistic, often expressing itself in exalted (though always simple) idiom and imagery that remind us of the much more intricate seventeenth-century 'metaphysicals'. His idea of man's place in Nature, utterly contrary to Huxley's, as gathering to a point the joy and exuberance of natural life and through it finding contact with the unseen world, as drinking deep of the life of Nature but observing a royal impartiality towards its phenomena and refraining from interference with its balances and interdependences, this mental approach is a philosophical rendering of a primitive feeling. Hudson loathed all human rapacity towards Nature, but disdained the sentimentalism of reproaching "the cruelty of Nature" in raptorial bird or beast. His mind was entirely estranged from that of civilization because its home was both behind and beyond it.

The Russian lecturer, Nicolas Berdyaev, directs a searching criticism against the modern theory of progress on the ground that it disintegrates time into past, present and future, which are spectral in the sense that each devours the other. Hudson's work is an apt illustration of these three divisions of time in a mutual and non-destructive relation to one another. To Hudson the primitive past was the deepest source of his inspiration, and through it he envisaged a future of the relations between man and Nature which would enshrine their reconciliation. His most famous book, "Far Away and Long Ago", reveals a more personal fusion between boyhood and old age (it was written when he was seventy-six) inexplicable from the point of view of an enkindled memory alone. This minutely detailed record of his childhood on the Argentine pampas is perhaps the most astonishing example of re-animation in our literature. The entire wild scene with its people, its flowers and animals, its effects of light and shade, together with his own sentiments and adventures and reactions, are presented as a living whole with such immediacy that the gaps both of time and space are annihilated. Hudson *senex* evokes a Hudson *puer* not of yesterday, but contained within the present, and there is no other word for this but mystery.

A passage in "The Land's End" illuminates this merging between past and present, boyhood and age, beginnings and ends, the primeval and the more-than-civilized from another and yet stranger aspect. One of a party of grey pilgrims looks over

the sea from the end of all the land, the ancient Bolerium:

"He sees only what his heart desires—a silent land of rest. No person will greet him there, he will land and go up alone into that empty and solitary place, a still grey wilderness, extending inland and upward hundreds of leagues, an immeasurable distance, into infinity. . . . The sky in that still land is always pale grey-blue in colour, and the earth, too, is grey like the rocks, and the trees have a grey-green foliage—trees more ancient in appearance than the worn granite hills. . . . There he will remain motionless and contented for ever in that remote desert land where is no sound of singing bird nor of running water nor of rain or wind in the grey ancient trees. . . ."

This "illimitable wilderness" is antediluvian and post mortem, the beyond and the uncreate; it is the Land's End and it is Patagonia that he loved even better than his estancia-home of La Plata, where the bright birds sang in the peach-grove; it is the goal of age and the longing of youth; it is intensely symbolic and yet an actual scene. It is all these things in one, and it is thus a conquest of time in total opposition to the modern "conquest of nature" and enslavement to a time arbitrarily sliced up into three divisions.

We shall never understand Hudson unless we see him bathed in this mysterious light, unless we look for him within the heart of Nature where the visionary is inseparable from that which is observed, beauty and romance are fused with an objective natural history and where to see, to know, and to feel are a triune experience. Only one link in the chain of integration is missing, and that is the craft of husbandry, where Nature and man meet on equal terms. But the primitive wildness that was the heart of Hudson did not permit him to surmount the last impediment to a final synthesis. Yet in closing the division between natural truth and poetic beauty without doing violence to either, he, the primitive, must surely rank among the very greatest of modernists. The war of aggression against Nature by means of the machine and the combine would have been profoundly antipathetic to both these elements of his complex being.

As a 'stylist' Hudson is impossible to anatomize. His is not a literary way of writing at all, still less has it any affinity with modern cultism in self-expression. He wrote just as he thought, narrated, described, and speculated—namely, as a child of Nature raised to a high degree of self-consciousness. His manner of writing, that is to say, is the natural manner of growth in the plant, of flight in the bird, and of movement in the wind or the sea. There are no spot-lights in metaphor or imagery, nor is there any sense of manufacture in the structure of the sentences. At times a page will be a flat monotone like a dull day; at others like a spring morning, when the dew is on the spray. His argument, whatever it may be, unfolds itself like a vine tendril or a clematis shoot making its unobtrusive way into the sunshine. Or the pace quickens and a tuft of bright-coloured flowers appears on the green background. His style is thus a method of articulation in perfect harmony both with his subject and his own mystical and intuitive contact with the childhood of mankind. The man who identified himself with all creation and through it felt the touch of the unseen conveyed into his writing the sense of a lost world "where the rose has got Perfume that on earth is not", an Adamite paradise of Nature which has haunted the imagination of the more sensitive among men since the days of Hesiod.

OBITUARIES

Prof. A. J. Clark, F.R.S.

By the death, on July 30, of Prof. A. J. Clark, at the age of fifty-five, pharmacology has lost its leading exponent in Great Britain. He was born in Somerset in 1885, went to Bootham School, and obtained one of the first major entrance scholarships in science at King's College, Cambridge. After an unexpectedly brilliant performance in the Tripos, he went as a student to St. Bartholomew's Hospital, London, and took the degree of M.B. in 1910. He worked with Zunz for a time, and then became Cushny's assistant at University College, London. He was professor of pharmacology in Cape Town, and then succeeded Cushny, first at University College, and then in Edinburgh, where he had been since 1926.

During the War of 1914–18 Clark served in the R.A.M.C. as a captain, and was awarded the M.C. During the present War it was natural that he should be appointed physiological and medical adviser to General Headquarters. He went out to France in 1940 as a lieutenant-colonel just in time to play his part in the withdrawal of the British forces.

He married Beatrice Powell, daughter of the late Dr. Hazell of Cape Town, in 1919, and had two sons and two daughters.

Clark's restless energy and wide knowledge were evident both in his work and in his conversation, and were always available for the assistance of his colleagues, but his general knowledge was also great, and his advice was valued by all. He was a member

of the Medical Research Council from 1934 until 1938 and from 1939 until the time of his death.

He was a great experimentalist, and his interests, both in physiology and pharmacology, were so varied that it is difficult to select a representative list of his discoveries. No one else knew so much about frogs' hearts and how to control them, and no one would have thought it possible to extract so much information from them. He found that the action of digitalis was dependent on the presence of calcium. He found that the washings from frog's heart and serum both contained unknown substances which increased the force of the beat. He published important studies of the pharmacology of peptone and of potassium. With Broom he devised a well-known method for the assay of ergotoxine. In 1927 he published a book on "The Comparative Physiology of the Heart", and in 1938 he published another on "The Metabolism of the Frog's Heart", which was largely based on his own work with various collaborators.

Clark's main interest was in the light thrown by quantitative pharmacological experiments on the fundamental problem of how drugs act. He wrote a book called "The Mode of Action of Drugs on Cells" (1933), and a supplementary volume to Heffter's Handbook called "General Pharmacology" (1938), in which he codified a large number of papers in this field. The original authors had treated their results in all sorts of ways, and reached all sorts of conclusions. Prof. Clark replotted, recalculated and tabulated their results by uniform methods. He emphasized the danger of fitting simple curves to observations on complex living tissues by showing that the results could often be equally well fitted by several different simple curves. He cleared the air by demonstrating that "an intensive study of any particular pharmacological action nearly always results in showing it to be more complex than was at first supposed". His wide knowledge provided a very rich mine of examples to illustrate his arguments, which were upheld by many experiments of his own and his students. In all this work he was testing the validity of fundamental quantitative generalizations. He was seldom content with direct empirical observations of the effect of chemical structure on pharmacological action.

Clark's "Applied Pharmacology" was first published in 1923, and six more editions appeared in the next seventeen years. This book, in which particular emphasis is laid on experiments on man, has played an important part in the development of the science of experimental therapeutics; it serves as a link between the laboratory and the ward.

J. H. Gaddum.

We regret to announce the following deaths:

Dr. Frank Haydon, formerly Secretary of Apothecaries' Hall and for many years oculist to the Southern Railway, on August 1, aged seventy-nine.

Dr. A. L. de Morais Sarmento, the well-known Portuguese physician and Rector of the University of Coimbra, on August 11, aged fifty-three.

NEWS AND VIEWS

Sir Robert Robinson: First Paracelsus Medallist

A delightful function took place at the Dorchester Hotel on August 6, when the Swiss Ambassador, in an after-luncheon speech, presented to Sir Robert Robinson, F.R.S., Waynflete professor of chemistry in the University of Oxford, the Paracelsus Gold Medal of the Swiss Chemical Society. This is the first occasion upon which the award has been made, and it is gratifying that the Swiss chemists should recognize in this manner Sir Robert's pre-eminence in the scientific world. His versatility is such that he has enriched every branch of organic chemistry, but it is perhaps as a master of the synthetic method that he has gained special fame. His outstanding gifts in this direction became evident early in his career, when in 1917 he effected a synthesis of tropinone, noteworthy on account of its extraordinary novelty and simplicity. The concept upon which this and other alkaloid syntheses was based was a direct outcome of a comprehensive theory of biogenesis of plant products which was contributed to the Chemical Society in the same year, and which marked an epoch in alkaloid chemistry.

Other outstanding achievements in this field include a large number of inspiring memoirs on the indole group of alkaloids, the morphine group, including a modification of Knorr's morphine and thebaine formulæ and finally the establishment of the correct structures of strychnine and brucine. Robinson's interests have, however, extended far beyond the alkaloid field. One recalls the brilliant work carried out in association with W. H. Perkin, jun., on the constitution of brazilin and hæmatoxylin; from this arose his interest in pyrylium salts, leading to elegant synthetic work on anthocyanidin structures and culminating in the striking achievement of the synthesis of the anthocyan flower pigments themselves, one of the finest pieces of research of our generation. And now another trail is being blazed, this time on the synthesis of steroids and sex hormones; here, as always, with Robinson's work, one is struck by the simplicity and freshness of approach and the ingenuity displayed in building up the required ring-systems. No account of Robinson's work would be complete without mention of his important contributions to the theory of organic reactions, crystallized finally in terms of modern electronic hypotheses relating to the nature of valency bonds. The theory which collates on a common basis a diverse mass of data in organic chemistry, has had an important influence in the development of the science.

Prof. Edgar Allen: Bayly Medallist

PROF. EDGAR ALLEN, to whom the Bayly Medal of the Royal College of Physicians has just been awarded, is professor of anatomy in the Yale University School of medicine, a post to which he succeeded in 1933 after a very fruitful period of office in the University of Missouri. In both universities his department has proved a vigorous centre of research on the sex hormones, and his own contributions to the subject form an essential foundation to modern knowledge of the endocrine action of the ovaries. Before 1917 attempts to isolate ovarian internal secretions were seriously handicapped by the lack of a specific test for what to-day is called œstrogenic action. In that year Stockard and Papanicolaou showed that the œstrous cycle in the guinea pig is associated with cyclical changes in the vaginal epithelium. Shortly afterwards Allen found that in the mouse, too, œstrus is associated with a specific vaginal phase, and from this discovery it was a short step to his and Doisy's successful application of the vaginal smear technique as a test for the œstrogenic action of ovarian extracts. Once extracts with demonstrable œstrogenic activity were made available, the door was open to the chemical isolation, analysis and synthesis of pure œstrogens. Although Allen did not share in this later chemical work, there can be little question that it would have proved impossible without the simple bio-assay method which he developed.

Allen's second major achievement was his demonstration in 1926 of the fact that the follicular phase of the uterine cycle in monkeys and man is under the control of œstrogenic hormone. All later work on the primate cycle emerges from this finding, and Allen's own subsequent investigations have a significant place in the structure of present knowledge of the subject. His contribution does not rest here. Allen is that rare combination of research worker and administrator who is able to stimulate in younger men a strong and lasting interest in research. His laboratory is one of the most productive in the United States, and while the Bayly Medal is a recognition of past work, endocrinologists the world over know that Allen's laboratory will prove no less successful in the future than it has in the past.

Mr. Orville Wright

MR. ORVILLE WRIGHT celebrates his seventieth birthday on August 19. It was he who, together with his late brother, Wilbur, first flew a heavier-than-air machine on December 17, 1903, at Kitty Hawk, North Carolina, and, also with his brother, invented the system of control used in flying machines to-day. The first flight lasted only twelve seconds, but further experiment and trials resulted in the development of an aeroplane which established a new record on September 12, 1908, by remaining in the air for seventy-five minutes. The Wright brothers began their investigations on kites and gliders in 1900. Then they introduced two improvements: (1) the elevator for steering the machine in a vertical plane, which, though now usually attached to the tail, was placed by them in front of the main planes; (2) flexing of the rear edge of the main planes so as to vary the lift on either or both, thus maintaining balance. A petrol motor-driven screw was added in 1903.

The Wright brothers were also great exponents of the use of the wind tunnel in aeronautical investigations. The first motor-driven machine which was used by the Wright brothers in their pioneer flight on December 17, 1903, is now exhibited in the Science Museum, South Kensington. Wilbur died on May 30, 1912. Both brothers have been the recipients of several medals, honorary degrees and other honours. We offer our congratulations to Mr. Orville Wright on the attainment of his seventieth birthday.

Scientific Workers in Industry and Public Affairs

SIR ROBERT PICKARD'S address to the Society of Chemical Industry on the occasion of the presentation to him of the Society's Medal, was entitled "The Influence of Science on National Life", but his treatment of this theme was far less broad than the title. Before 1900, work by Faraday and Playfair, by E. Frankland and Roscoe, influenced the living conditions of the people through their respective investigations on the purity of water supplies and the purification of sewage effluents. Up to then, few research chemists were employed in industry, but between 1914–18 and the present time their number has much increased; and this is also particularly true of the lesser scientific workers (testers, etc.). Science has safeguarded and improved civilized life in innumerable ways; nevertheless doubts and questions have arisen whether the nation makes adequate use of the scientific ability at its disposal. On the whole, Sir Robert is satisfied with the tremendous improvement in such matters that has occurred in the last twenty-five years. Scientific men are not specially competent to deal with certain political and social questions, but they can reasonably claim to be consulted before decisions are made.

Though many of the recent criticisms of the Civil Service seem to Sir Robert to be unjustified, those concerning reluctance to take decisions and lack of foresight in formulating problems, appear to be valid; if so, they are due in part to the cloistered life the Civil Servant has to lead. The same cause may operate among scientific workers employed in industry, and Prof. A. V. Hill's plan of regular interchange between scientific staffs in the civil and municipal services, and in university laboratories, should at least offer a partial remedy. As fellows of the Royal Society are, when elected, nearly all specialists of the highest, but narrowest, type, their services to the nation are most likely to be effective when the problem is entirely novel. We in Britain have "led the field" in applying science to the older industries; in the newer industries, based upon recent discoveries, American scientific workers have made "greater bulk endeavours". The modern central research association is also a typically British product, but there is need of reform in current methods of electing directors or heads of such bodies; such heads have in the past been largely "thrown up

by the tide", and we must now seek some method of training the successors of those men who are the present leaders. A head can be a success only if he agrees to cease his work as an expert, after appointment.

Great Britain and the U.S.S.R.

THE British Association has received the following message in reply to a resolution recently forwarded through M. Maisky to the U.S.S.R. Academy of Sciences (see NATURE of August 2, p. 135): "The Academy of Sciences of the U.S.S.R. sends warmest greeting to the Committee for Social and International Relations of the British Association for the Advancement of Science. With the help of scientists of both our countries the united peoples of Great Britain and the Soviet Union will triumph in the war for the liberation of humanity from Fascist tyranny. Otto Schmidt, vice-president, Academy of Sciences of the U.S.S.R."

U.S.S.R. Academy of Sciences: Air Raid Damage

ACCORDING to the British United Press, it can now be revealed that German raiders recently set fire to the library of the U.S.S.R. Academy of Sciences, one of the most famous landmarks in the city. The fire was put out, however, before any of the three million valuable books in the library were destroyed. It may be recalled that the Germans, during the early raids on Moscow, boasted that the Academy of Sciences had been destroyed.

Black-out *v.* Controlled Lighting for Air-raid Defence

THERE has always been controversy upon this subject, and while Britain has adopted the complete black-out in this War, there is a considerable opinion held in the United States that some form of uniform lighting, to disguise landmarks, would be equally effective and less hampering to the inhabitants of the district. Experiments are being carried out, but the problem is not capable of any very precise solution, as the results are entirely dependent upon the personal estimation of the observers from the air. Even in an actual attack, the results of bombing depend upon so many variable factors that it would by no means follow that the concentrated bombing of a certain district was due to its ineffective concealment.

The principal arguments against a black-out are the impossibility of hiding rivers, railways and long, straight roads; fires and enemy agent signals are more obvious; dropping of flares effectively lights up at least a limited area. It adds to the difficulties of all forms of defence and A.R.P. work during an attack, and it hampers all work and social life as it is necessarily applied continuously, since it has been proved that it is impracticable to bring black-out into operation only when an attack is expected. It is claimed that a uniformly spread mantle of light would not make a town any more obvious, and could be made to disguise any particular object equally well.

The difficulty lies in obtaining uniformity, with the different classes of buildings, open spaces with no buildings or roads, and the irregular contour of the city that could be co-ordinated with a map. There is the further problem of enforcing that uniformity when it is attained. Watching the observance of a complete black-out is easier than seeing that a certain standard of illumination from windows, roof lights, etc., is not exceeded. Uniform lighting was used in London and certain other towns towards the latter part of the War of 1914–18, but this was introduced as an alternative to a black-out not nearly so completely worked out or rigidly enforced as the present one. There is also the wider problem of using individual towns as landmarks for navigating purposes. A series of lighted patches, indicating towns, could easily be followed successively with the aid of a map, and made to lead to any desired district. Uniformity of lighting in this respect could only be attained by illuminating the whole country-side—a task of gargantuan magnitude.

Fire Prevention in War-time

MANY of the subjects covered in a lecture delivered to the Royal Society of Arts by Colonel G. Symonds, fire adviser to the Home Office, are of more than general interest. After discussing questions of organization and the need for adequate fire-fighting parties to take immediate action, Colonel Symonds dealt with the 'protective levels' required for resisting penetration by a 1 kgm. incendiary bomb. The figures he gave were: reinforced concrete $2\frac{1}{2}$ in. thick; steel plate $\frac{3}{16}$ in. thick; a paving-stone 2 in. thick with a well-tamped standard sand-bag also gives adequate protection. As regards internal protection, floors can be made fire resisting with 2 in. of sand, $2\frac{1}{2}$ in. of brick rubble passing through $\frac{3}{8}$ in. mesh, or with material conforming to BSS/ARP 27. Less certain protection, but enough to enable a fire party arriving within five or six minutes to cope with the bomb, before floor boards started to burn, would be provided by BSS/ARP 47. Structural timber should be treated with a flame-resisting material. Communicated fire can be stopped by $2\frac{1}{2}$ inch jets supplied with 1,200 gallons of water a minute. Where an 80-ft. space is unobtainable as a fire break, windows facing a lesser gap should be bricked up, or failing this, protected with wired-glass and fire-resisting shutters. An unperforated 14-in. brick party wall with good mortar carried 10 ft. above floor-level on the line of the break will often stand up well to a 'near miss'.

Biochemistry at the Franklin Institute

THE Biochemical Research Foundation Laboratory (formerly the Cancer Research Laboratories), under the direction of Dr. Ellice McDonald, has recently moved from Philadelphia, Pa., to Newark, Delaware. The buildings at Newark are new and specially designed for the work of the Foundation. One wing insulated from the main rooms contains a cyclotron for preparing radioactive substances for use in medical and biochemical problems. The laboratories

appear to be admirably equipped for research in physics, physical chemistry and biochemistry. Miss G. E. Woodward is still carrying on with her researches on the metabolism and structure of amino acids. In this new institute it is expected that close co-operation between chemists, physicists and biologists will lead to new advances.

Rapid Black-out of a Factory

A DESCRIPTION is given in the *Electrical Review* of July 11 of a method of almost completely blacking-out in a few seconds a factory by simply pressing a button. A camouflage installation recently completed at a large factory provides for blacking out 550,000 sq. ft. of roof lights in 15 sec. Originally hard wall-boards were fitted to the outside of all the north lights and other windows. Alternate panels have been removed from the north light windows and fixed into a frame in their respective positions over the windows, the frame being made to move laterally across the whole span of lights through grooves cut in the sections fixed to the glazing bars. Steel cables were fixed to each end of the frame, passed over spring-tensioned pulleys and secured to a winch mounted on the wall inside the factory. The winch is operated by a ¼ h.p. D.C. compound-wound G.E.C. Witton motor. The forward and reverse movements of the shutters are obtained by reversing the direction of the motor, which is controlled by forward and reverse contactors operated by two limit switches. The latter are tripped by 'fingers' mounted on steel rods secured by the cables, which travel up and down through a distance equivalent to the movement of the steel frame. Each span of lights of approximately 1,000 sq. ft. is operated by one ¼ h.p. motor, and more than 500 motors have been installed. In the event of damage to the electrical equipment, the motors can be disconnected and the winches operated by hand in each individual bay.

New Tone for Dial Telephone Systems

IN long-distance telephony when messages or signals have to be transmitted simultaneously over wire networks, an error in dialling may result in reaching a group of numbers not assigned for service. In such cases a special tone may be used to inform the customer of his error, and this special development in switching is widely used in the Bell System networks of the United States. In the *Bell Laboratories Record* of April, Mr. M. E. Krom communicates a paper giving the development of the 'no such number' tone. The new tone varies continuously in frequency, like that of a siren, alternately rising and falling at half-second intervals. The sound is quite different from any other tone used in the Bell system. At the lowest pitch the fundamental frequency is 200 cycles per second, and at the highest pitch, 400 cycles. Harmonics up to 6,000 cycles are in both tones, and these give the latter a richness not found in single-frequency waves. The tone is generated by a 'relaxation' oscillator consisting of a vacuum tube, condenser and resistance. The tone is amplified by another vacuum tube which raises the level above that of the dial and busy tones. To lengthen the life of the vacuum tubes, the plate circuits are closed only when the tone is required ; the filaments are continuously heated, however, to maintain the circuit in readiness for instant service. During field trials it has reduced circuit-holding time on numbers wrongly dialled and resulted in a higher percentage of correct numbers on the second dialling.

Egyptian Astronomy

HERBERT CHATLEY has given in a paper on "Egyptian Astronomy" (*J. Egypt Archæol.*, **26**, 120 ; 1940) certain conclusions regarding the various figures found in the Egyptian "celestial diagram", of which nearly twenty copies from the Eleventh Dynasty down to Roman times are in existence. The general deductions that have been made about the figures are included under eight categories, but limits of space do not permit any detailed description ; those who are interested in Egyptian archæology will find it profitable to study the paper carefully. It is difficult to discover from reading the account of the constellations, Dekanal Band (the dekans were 10-day stars from the helical risings of which the ten-day week of the Egyptian year was marked), Meta-Dekans, etc., how much astronomical knowledge the Egyptians really possessed. Popular belief credits ancient Egypt with extensive knowledge, but archæological research scarcely supports this view in the realm of astronomy. The records show very little regarding the actual observations of their inventors, and many of them are of a magical or religious nature the object of which was to protect or assist the dead. The author has previously expressed the opinion that the dekanal lists were revised about the beginning of the New Kingdom, about 1600 B.C., and he conjectures that the celestial diagram was invented then as a talisman which concentrated the power of the heavenly bodies into one form.

Mathematical Problems in Seismology

A. BLAKE has recently directed attention to many outstanding problems in mathematical seismology (*Trans. Amer. Geophys. Union*, 1940). The following problems are, more particularly, mentioned : (1) Problems in the theory of seismic waves due to inhomogeneities in the media and other causes, and to new methods available for the study of the interior of the earth. (2) Problems of instrumental seismology including the new strain meter and rotation seismograph. (3) Problems relating to the complexities encountered in determining the response of engineering structures to the motion of a strong near earthquake. (4) Problems of statistical seismology, especially the periodicity problem. In many cases Blake states that seismological calculations may be performed by machines such as the differential analyser and punched card machines.

Concerning strong-motion problems, Blake says that the analysis of the response of a structure into characteristic or normal components satisfying linear equations depends on the treatment of the strain-

energy function as quadratic. But the purpose of investigating the response to destructive earthquake motions requires consideration of strains much exceeding the limits within which Hooke's Law remains valid. According to the author, the linear theory can then only be used as a first approximation and the effects of the various components of ground motion cannot be treated separately. The Rayleigh dissipation function may be important but the case of small damping including the existence of normal modes of oscillation has been encountered in the case of buildings, bridges and tank towers. The paper will act as a signpost towards further progress in mathematical seismology.

Epicentres of the Earthquakes of April 20 and 21

THE U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentres of two recent strong earthquakes. The first on April 20, 1941, at 17h. 38·3m. G.M.T., had an epicentre near lat. 37° N., long. 69° E., which is in Afghanistan and some 160 miles north of Kabul. The second, on April 21, 1941, at 2h. 54·1m. G.M.T. was near lat. 53° N., long. 166° W. which is in the neighbourhood of the Aleutian Islands. Both these areas are well known to be frequented by earthquakes, the Aleutian Islands area having been particularly active in recent months.

Forestry in Uganda

IN the annual report for the year ending December 31, 1940 (Entebbe, Govt. Printer, Uganda, 1941), the Conservator, after detailing the total areas of forest under control, says that under a reclassification of the forests the area of protection reserves has increased at the expense of production reserves. Except for forty-eight square miles of high forest, all the new areas gazetted were savannah land or bush-covered hills with some gallery forest in the valleys. For those with an acquaintance of local African conditions this reservation of savannah and bush lands is of the greatest significance and the Forest Department may be congratulated on its action. It is not the less disturbing, therefore, to read that "Reconnaissance continued on a reduced scale and there are still some 1,000 square miles in the Eastern and Western Provinces which are known to require reservation. In Buganda the need for reconnaissance and reservations was recognized by Government, but staff was not available to make a start." This question, the inadequacy of staff, has interrupted other valuable work in progress. It cannot but be disheartening to Forest Departments when the Administration responsible are unable to realize that forest property and management differ widely from the short-term (in years) policy with which agricultural lands can be treated. In the general interests of the communities as a whole, especially when more or less directly dependent upon the forests, not even the stresses of an Empire War should be allowed to imperil the future of such forest areas.

The Health of Canada

THE April issue of the *Statistical Bulletin* issued by the Metropolitan Life Insurance Company of New York contains an instructive editorial on the health of Canada in 1940. During the last three months of 1939 and almost the whole of 1940 the mortality record in Canada was very favourable; but it showed some rise in December and the first quarter of 1941 owing to the epidemic of influenza which occurred at the end of 1940. As a whole, however, the standardized death-rate of the Canadian Industrial policy holders less than seventy-five years of age was only 592·1 per 100,000, or 12·1 per cent below the average rate for the five preceding years. Among children the drop in mortality was as much as 30 per cent. The greatest improvement took place in the acute and infectious conditions, while cancer and diabetes showed higher rates than in previous years. The decline in the principal infectious diseases in children, namely, measles, scarlet fever, whooping cough and diphtheria was 43 per cent since 1935–39. For measles and scarlet fever the rate was less than two thirds of the average for the preceding five years, and for diphtheria the 1940 rate was little more than one half of the earlier rate. Whooping cough, with a rate of 5·1 per 100,000 in 1940, or more than that for the other three combined, is to-day the most serious of these diseases of childhood. Diseases of the heart, arteries and kidneys together accounted for more than one third of the mortality. As regards tuberculosis the death-rate for the first time fell below 50 per 100,000, the decline since 1935 being 15 per cent. Child-bearing has become definitely safer in Canada, the puerperal death-rate having fallen to 6·2 per 100,000 in 1940 from 9·0 in the preceding five-year period. Lastly, there was an appreciable decline in deaths from violence.

Public Health in Haiti

ACCORDING to Dr. Rulx Léon, Under-Secretary of State in Charge of the Health Service and Public Assistance, a major concern of the Health Service of Haiti is the lack of adequate drinking-water facilities, which is particularly serious in the capital. During the past year, the Government created a public welfare organization which established several hospitals in different parts of the country. 31,202 cases of malaria were treated in hospitals and Government rural clinics. Dysentery and intestinal parasitism existed in endemic form. Outbreaks of measles, ringworm and influenza were quickly controlled. A mild epidemic of diphtheria broke out in the capital. The principal causes of death were tuberculosis, malaria, enteritis, syphilis and pneumonia. A total of 47,950 births and 12,907 deaths was recorded.

Historical Medicine and Science

UNDER the title of "Medical Miscellany: List A" Schuman's, of 730 Fifth Avenue, New York, have published a catalogue of 150 works of historical medicine and science. Of special interest are Abernethy's Hunterian Oration for 1819, von Behring's early contributions on the specific treatment

of diphtheria and tetanus, anthrax, immunity, etc. (1893), the works of Fabricius ab Aquapendente (1619–20), James Lind's "Essay on Diseases incident to Europeans in Hot Climates" (1792), the Life and Letters of Michael Faraday (1870) and George E. Ellis's Biography of Count Rumbold (1871).

The principal feature in Schuman's List B is the inclusion of nine items concerning Paracelsus, the fourth centenary of whose death takes place this year. These items are a Latin translation of one of his principal works, embodying much of his work on chemical therapeutics (1578), his surgical writings in Swiss-German (1605), English translations of Leonardo Fiorovanti's work (1653), Paracelsus's hermetic and alchemical writings (1894), and his one hundred and fourteen experiments and cures (1652), Franz Hartman's "Life of Paracelsus" (1896), the first edition of Browning's poem (1835) and an early seventeenth-century portrait of Paracelsus from the G. Ritter von Frank collection.

Colour Changes in the Paradise Fish

It is well known that the paradise fish, *Macropodus opercularis*, is capable of changing its colour. Y. C. Chin and J. C. Li (*Peking Nat. Hist. Bull.*, 15; 1941) have shown that such changes can be induced by changes in light intensity, temperature and the environmental colour. Their experiments indicate that in the performance of this reflex the eyes act as the receptors and the melanophores as the effectors. The receptor and effector systems communicate in the medulla oblongata. The melanophore nerves appear to be of two kinds, one concentrating and the other dispersive. The actual changes in the melanophores are brought about by the secretion of neurohumours secreted at the ends of the nerves and these are not transmitted by the blood but diffuse from cell to cell. The authors have attempted to express the results in quantitative terms that will permit of more accurate comparisons in future work.

Sawflies of the Berkhamsted District

Mr. R. B. Benson has given students of Hymenoptera valuable help with his paper "Sawflies of the Berkhamsted District" (*Trans. Herts. Nat. Hist. Soc.*, 21, 177–231; 1940). The work is divided into three parts: (*a*) Introduction, (*b*) List of Species, and (*c*) References.

In (*a*), among other matters, the author compares on a percentage basis the number of species—313—taken in Hertfordshire with the other insect groups which have been collected in the county, but takes care to point out that the results tend to show what groups have been best collected rather than the relative abundance of any one of them. The sawflies head the list with 72 per cent, a figure which on either count speaks much for the energy and untiring patience which the author has brought to the task of collecting these insects. Attention is directed to the fact that the abundance of a species may vary within very wide limits over a large number of years. Zoogeographical and ecological aspects are also discussed. Range of locality in Hertfordshire, frequency of occurrence, times of appearance and food-plants of the species are given. The table of references comprises fifty-five items.

Prof. Olof Hammarsten (1841–1932)

Prof. Olof Hammarsten, the celebrated Swedish biochemist, was born at Norrköping in Sweden on August 21, 1841. He received his medical education at Uppsala, where he qualified in 1869, and was assistant at the laboratory for clinical chemistry and the physiological institute. In 1877 he was appointed extraordinary professor of physiology at Uppsala, where he became professor of medical and physiological chemistry in 1883; he held this post until his retirement in 1906. His chief work was his text-book on physiological chemistry, which for many years stood almost alone as a work of reference and was translated into several foreign languages. He had previously won a high reputation by numerous contributions to biochemistry, including the milk-curdling properties of gastric juice, the behaviour of rennin, the role of calcium in the clotting of milk and blood, the proteins of the blood and the mucous substances in the bile. In 1906 he was the recipient of a *Festschrift* which contained a bibliography of his writings up to 1905. He died on September 21, 1932.

Announcements

Prof. J. C. Drummond, professor of biochemistry in the University of London and scientific adviser to the Ministry of Food, has been elected Fullerian professor of physiology in the Royal Institution in succession to Sir Frederick Keeble.

Prof. C. Lovatt Evans, Jodrell professor of physiology in University College, London, has been elected a foreign member of the Royal Physiographical Society of Lund, Sweden.

At the recent conferring of degrees at the Queen's University, Belfast, the degree of doctor of science was conferred on Bryan A. Toms, of the Department of Chemistry of the University.

The Swedish International Press Bureau reports that a board for the control of incorrect or misleading advertisements of medical preparations has recently been appointed in Sweden consisting of representatives of the Royal Medical Board, the Swedish Medical Association, the Federation of Swedish Industries, the Advertising Association and the Newspaper Publishers' Association.

The next award of the Rolleston Memorial Prize, now worth about £100, will be made in Trinity term, 1942, and graduates or research students of the Universities of Oxford or Cambridge, within ten years from matriculation, are eligible. The prize is given for original research in animal and vegetable morphology, physiology or pathology. Essays should be sent to the Assistant Registrar, University Registry, Oxford, before March 31, 1942.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Reactions of Carboxylic Esters

ALTHOUGH, as pointed out in a recent review[1], acid or alkali catalysed hydrolysis or esterification and, it may be added, alkoxy interchange, usually take place by mechanisms in which the bonds of the alkoxyl carbon atom are not disturbed (mechanism I), the alternative mechanism (II) does, however, occur, and probably to a greater extent than has previously been recognized, when the alkoxyl group R″ has electron-releasing properties.

$$R'CO \mid OR'' \ (I) \qquad R'.CO.O \mid R'' \ (II)$$

This fact was brought to our notice during the preparation of some optically active $\alpha\gamma$-disubstituted allyl alcohols. Whereas in the alkaline hydrolysis of the hydrogen phthalates of a large number of optically active saturated aliphatic alcohols under varying experimental conditions no racemization has ever been observed, the optically pure hydrogen phthalic esters of the substituted allyl alcohols, when submitted to hydrolysis with only a slight excess of alkali, yield the partly racemized alcohols; when larger proportions of alkali are used optically pure alcohols are obtained[2]. Mechanism (II) implies dissociation of the ester into a carbonium cation and an anion. If the cation is mesomeric, as it is in the esters of the substituted allyl alcohols, rearrangement is to be expected[1], leading to a mixture of alcohols when mechanism (II) is operative. This has, in fact, been observed: α-phenyl-γ-methylallyl hydrogen phthalate, on hydrolysis by means of a slight excess of 5*N* aqueous sodium hydroxide, yields a mixture of α-phenyl-γ-methyl- and γ-phenyl-α-methylallyl-alcohols[3].

We have further observed that esters of these optically active unsaturated alcohols, when warmed with carboxylic acids or with alcohols, yield esters or ethers with extensive loss of optical purity and therefore, presumably by mechanism (II)[4]. This behaviour is in marked contrast to that of esters of saturated aliphatic alcohols: the hydrogen phthalate of octan-2-ol, for example, can be recrystallized unchanged from hot glacial acetic acid[5]. We also find that esters of phenylmethylcarbinol and of the naphthylmethylcarbinols react in a similar way with acids and with alcohols; we have not, however, observed the occurrence of racemization during the alkaline hydrolysis of the hydrogen phthalates of these carbinols.

The powerful electron-releasing effect of the *p*-methoxyl group causes the above-mentioned reactions to occur very readily with esters of anisylmethyl- and anisylphenylcarbinols. These esters, moreover, are easily decomposed, yielding *p*-methoxystyrene and $\alpha\alpha'$-di-*p*-methoxyphenyldiethyl ether and $\alpha\alpha'$-di-*p*-methoxyphenyldibenzyl ether respectively. The hydrogen phthalic esters of these two carbinols when warmed with dilute alkali yield the neutral esters (di-anisylmethylcarbinyl- and di-anisylphenylcarbinylphthalate).

All these observations are explainable on the assumption that the esters dissociate according to mechanism (II), and detailed descriptions of the reactions are in preparation. An analogous reaction is the racemization, without any observable evidence of decomposition or side-reaction, of the acetate of octan-2-ol, when heated in acetic acid solution with one molecular proportion of a strong acid (for example, *p*- toluenesulphonic or sulphuric acids). This reaction, which may be due either to dissociation or to a continued series of Walden inversion reactions, is at present the subject of further study.

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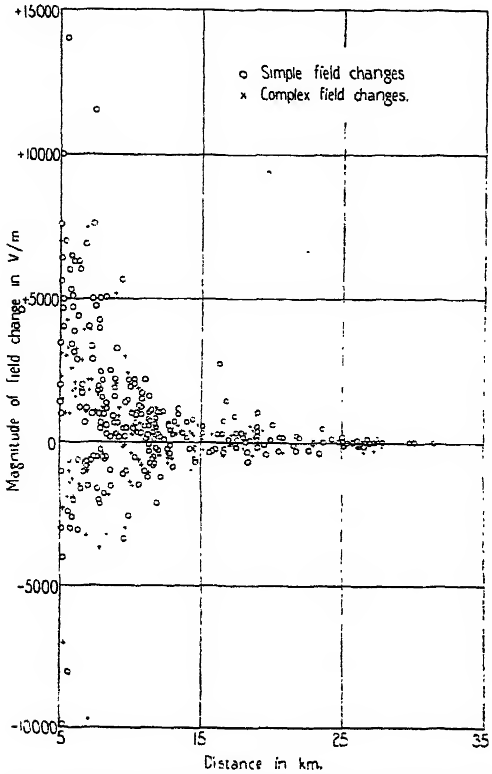
July 18.

[1] Watson, Ann. Repts. Progress of Chemistry, 27, 229 (1940).
[2] Arcus and Kenyon, *J. Chem. Soc.*, 1912 (1938).
[3] Kenyon, Partridge and Phillips, *J. Chem. Soc.*, 216 (1937).
[4] Reference (2) and unpublished results.
[5] "Organic Syntheses", 6, 68.

Errors of Observation due to Instrument Scale Limitations

IN the course of a recent investigation of the lightning discharge[1], it was found that scatter diagrams showing the variation with distance of the field changes set up by lightning flashes are liable to misinterpretation owing to a limitation in the recording apparatus which misses all records falling below a certain level. The effect of this limitation has been partly recognized by C. T. R. Wilson[2] in his investigations of the lightning flash, but has been overlooked in later publications on this subject[3]. The misleading effect due to this limitation is demonstrated below, and it is shown that a similar error of interpretation is liable to occur in many other cases in which a statistical analysis is based on data obtained with apparatus having a similar limitation.

The accompanying graph shows as an example the variation of the electrostatic field changes due to comparatively near lightning flashes. The recording electrometer, which was set to reproduce accurately the highest field changes that might be expected from nearby strokes, has a minimum recording limit which, as can be shown, excludes an increasing number of small values as the distance increases. This is shown directly by the fact that, assuming a uniform distribution of flashes, the number of records should from geometrical considerations increase with distance, whereas it decreases rapidly in the diagram reproduced. Again, while the spread of the data at any distance up to about 10 km. shows a ratio of about 50 : 1 between the maximum and minimum values recorded, this ratio decreases to about 10 : 1 at a distance of 20 km., though such variation has no foundation in the mechanism of the lightning



VARIATION OF FIELD CHANGES DUE TO LIGHTNING FLASHES WITH DISTANCE OF ORIGIN (WORMELL).

discharge. Finally, as the distance increases, the mean value shows a definite shift towards higher positions within the distribution of available test records, also indicating that an increasing proportion of the lower end of the distribution is lost.

If it be assumed that the average value at about 10 km. in the graph is correct, the variation of the electrostatic field changes with increasing distance can, as a first approximation, be assumed to vary inversely as the cube of the distance. In the accompanying table, calculated values are compared with the average values derived from the graph.

Distance, km.	10	15	20	25
Calculated, volts per metre	1385	413	175	89
From graph, volts per metre	1385	495	285	125
Appleton and Chapman, volts per metre	700	210*	88*	45

*Interpolated.

The table also includes field changes due to individual lightning strokes from Appleton and Chapman's observations[4]. As a first stroke of a multiple flash causes about one half of the total field change, it will be seen that the agreement of the latter with the calculated values is quite good, while the graph gives values which become increasingly too high as the distance increases.

Similar considerations probably apply to the observation of the variation of other radiation phenomena with distance, and the same fundamental difficulty will also arise elsewhere. For example, the attenuation of surges during their propagation along high-voltage transmission lines was first studied experimentally[5] by recording the amplitudes of surges due to lightning strokes at various points along such lines by means of the klydonograph. Whereas this method produces correct results for surges which show measurable amplitudes at more than one recording point, other surges which attenuate so quickly as to fall below the recording level of the instruments used at the second recording point will be neglected, and their omission will tend to suggest a rate of attenuation which would be too small if all waves had been taken into account. Later investigations with artificial surges confirm that the rate of attenuation as derived by the method described above was too small.

Still greater difficulties in the interpretation of test results are encountered in the determination of the average breaking strengths of insulating materials in a pendulum-type impact testing machine. In such tests, for which, as a rule, only a few specimens are available, the energy to be measured is that which is absorbed by the specimen when it is completely fractured. If the amount of energy absorbed is only a small fraction of that stored in the pendulum, it may be too small to be measured with the desired accuracy and the result is neglected. The same procedure is adopted if the energy of the pendulum is too small to produce fracture of the specimen. It is obvious from what has been said above that these omissions introduce an error in the determination of the average breaking strength additional to those already recognized[6].

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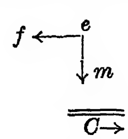
London, W.C.2.
July 22.

[1] Bruce, C. E. R., and Golde, R. H., *J. Inst. Elec. Eng.* (in the press).
[2] Wilson, C. T. R., *Phil. Trans. Roy. Soc.*, A, **221**, 75 (1921).
[3] Lewis, W. W., and Foust, C. M., *Trans. Amer. Inst. Elect. Eng.*, **50**, 1139 (1931). Lutkin, F. E., *Proc. Roy. Soc.*, A, **171**, 285 (1939). Norinder, H., *J. Frank. Inst.*, **218**, 717 (1934). Wormell, T. W., *Phil. Trans. Roy. Soc.*, A, **238**, 249 (1939).
[4] Appleton, E. V., and Chapman, F. W., *Proc. Roy. Soc.*, A, **158**, 1 (1937).
[5] Lewis, W. W., *Trans. Amer. Inst. Elec. Eng.*, **47**, 1111 (1928).
[6] E.R.A. Report, Ref. A/S36, *B.E.A.M.A. Journal*, **42**, 19 (1938).

A Relation between 'Motional' and 'Transformer' Induction

THE experimental facts about the action of electric currents on charges may be represented, with some mnemonic advantage, by the accompanying diagram.



C is a current of electrons, e a single electron in or out of a metal, m its direction of motion (which may be all round the clock), f the direction of the force on it due to C, when C is steady. When C is accelerating, e experiences a force in the same direction as if it were moving towards C.

The following remark by Cullwick[1] will be generally agreed to: "It would naturally be very satisfying if the two methods of inducing an e.m.f. could be shown to be particular cases of one general law, but

attempts to do this make use of philosophical speculations which are outside the realm of what is physically definable."

Now, the point in common between motion towards C, and increase in velocity of C, is increase in the angular velocity of an electron in C about the electron e. If v is velocity of the C electrons, and r the distance of e from the nearest element (charge q) of C, $d(v/r)/dt$ positive represents motion towards C, and we may write

$$F = -qe\frac{d(v/r)}{dt}.$$

For v constant, $F = \frac{qev}{r^2}\,dr/dt$, which is Ampere's Law.

For r constant, $F = -\frac{qe}{r}\,dv/dt$, which is Neumann's Law.

It would be interesting to know whether this relation has been already noted. If it could be generalized further to include motion of e parallel with C, the general law covering all forms of induction could be stated without any hypotheses concerning modes of action at a distance.

H. STAFFORD HATFIELD.

Thatch End,
Hildersham,
Cambs.
July 10.

Cullwick, E. G., "The Fundamentals of Electromagnetism" (Cambridge, 1939), p. 83.

Mechanics of a Flagellum

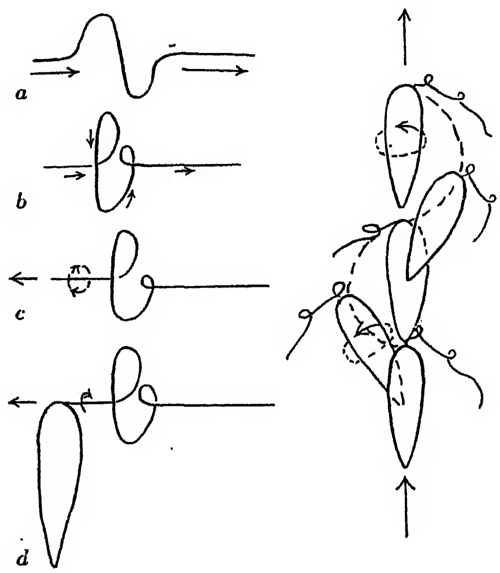
CONSIDER a simple homogeneous filament with a wave passing in the direction indicated and suppose that the filament is immersed in water (a). Allow also that the wave is passing along the filament with both an increase in velocity and amplitude and hence an increase in resistance from the water. It is then obvious, I think, that the wave must take up the form indicated (b). Thus the wave will pass along the filament with rotation in a clockwise or anti-clockwise direction. Let it be assumed that the rotation is anti-clockwise.

We are not concerned here with the nature of the force producing a wave, but that due to the wave acting on the water can be resolved into two components acting in different planes. The greater of the two forces will be one which would tend to force the filament to the left while the other would be acting in a clockwise direction with the main axis of the filament as its centre (c).

Now if we consider the filament to be a flagellum attached to a single cell such as that indicated (d) the one (the main) force of the flagellum would tend to push the attached end of the cell to the left while the other would tend to push the same tip of the cell below the plane of the surface of the paper. If, however, the inertia of the cell were greater than that of the distal end of the flagellum the effect would be to raise the greater part of the flagellum above the plane of the paper instead.

The continuous effect then of a series of waves passing along the flagellum at regular but frequent intervals would be to cause the tip of the cell to gyrate and rotate slowly as indicated in the diagram e, but it is obvious that the frequency of the waves passing along the flagellum must be high compared with the rate of rotation of the cell.

Now the following data have been obtained for *Euglena viridis* by means of high-speed cinema-photomicrography and direct observation. (1) The organism rotates about once per second. (2) Waves pass along the flagellum from base to tip at a frequency of 12–13 per second. (3) As the organism swims forward its anterior end gyrates and traverses a relatively large circle or spiral during the period of a single rotation. Contact prints showing flagella in motion were published in NATURE, 136, 210 (1936). The flagellar movement of several monoflagellates and biflagellates has been diagnosed in the same way, and the paper containing a full description of the method and results has been accepted for publication by the Zoological Society of London.



It is commonly assumed that these monoflagellates possess a *tractellum* or a flagellum in which the waves start at the tip and travel towards the base and thus draw the organism through the water. There seems to be no concrete evidence of the existence of such tractella.

A. G. LOWNDES.

Plymouth.
July 20.

Prevention of Seed-Borne Diseases in the Flax Crop

FURTHER to references[1,2] already made with regard to the prevention of seed-borne diseases in the flax crop, it may now be stated that the seed disinfectant RD.7846 prepared by Messrs. Imperial Chemical Industries, Ltd., and containing tetramethylthiuram disulphide as its active constituent, has been named 'Nomersan'. Through the good offices of Messrs. Imperial Chemical Industries, Ltd., and Messrs. Plant Protection, Ltd., 'Nomersan' was made available in bulk for the dressing of flax seed sown in Northern Ireland in the present season, and upwards of two thousand tons of seed were treated. Disinfection machines of the Strickland pattern were found to be very suitable for the continuous treatment of seed in large quantities, and machines of this type were used throughout the work.

No difficulties were experienced generally with the use of 'Nomersan', although in very occasional cases the powder caused some skin irritation when coming into continual contact with the faces and hands of the workers. During sowing operations when hand machines of the 'fiddle' type are used it is expedient for the sower to wear goggles in order to protect his eyes from the powder. This is of particular importance in windy weather, as the powder is apt to cause general eye discomfort, which is increased if the eyes are rubbed. Normally, it is of short duration and soon passes off.

A considerable quantity of seed was treated by the short-wet method using 'Ceresan U.564' as the disinfectant. For this purpose the 'Kontramix' machine was found to be quite satisfactory for the continuous treatment of seed in bulk.

Up to the time of writing, the crops from seed treated by either method are in good condition and no phytocidal effect has been noted.

A. E. MUSKETT.
J. COLHOUN.
Plant Disease Division,
Ministry of Agriculture, N.I.,
The Queen's University,
Belfast.
July 12.

[1] Muskett, A. E., and Colhoun, J., NATURE, 146, 32 (1940).
[2] Muskett, A. E., and Colhoun, J., NATURE, 147, 176 (1941).

Examination of Burnt Documents

IN present circumstances, the examination of documents recovered from receptacles which have been exposed to intense heat has become a matter of some importance, which has already been referred to in NATURE[1]. Many of these burnt documents have been incinerated at a high temperature in the virtual absence of oxygen and can better be described as 'carbonized' than as 'charred'. Such documents do not necessarily behave in the same way as specimens produced in the laboratory by incineration in air.

Carbonized documents are usually fragile, and those which are submitted for examination are presumably of value. It is a safe rule, therefore, to regard each document as a fresh problem in itself and to employ photographic methods of examination to the exclusion of any treatment which might damage or destroy the specimen.

I have, however, been employing a method for the treatment of carbonized documents written in ink, which appears safe and to give such good results as to merit its wider trial. It has been successful where other methods, including infra-red photography, have shown little if any trace of the writing. The method was devised by Superintendent Cherrill of New Scotland Yard and is published by permission of the Commissioner of Police of the Metropolis.

As I use it, the method consists in placing the carbonized sheet upon a glass plate in the bottom of a clean photographic dish and pouring over it a 5 per cent aqueous solution of silver nitrate. A second glass plate is lowered into the solution by one edge so as to exclude air bubbles. If the sheet is distorted, or especially fragile, it may be protected from the weight of the top plate by two glass rods placed parallel to the sides of the sheet. The dish should be protected from direct sunlight. Within about three hours the writing should be clearly visible as a black image against a grey background and is best photographed while the sheet is in the solution. The result obtainable, in contrast with that given by infra-red photography, which exhibits but little more detail than is visible to the eye, is shown in the accompanying illustrations. For permanent record the sheet may be rinsed in several changes of distilled water and then dried rapidly.

Where the original writing is faint, a weaker solution of silver nitrate may be employed, but it should then be allowed to act longer.

The method is simple and has the advantage of bringing up an image which is visible to the naked eye. It has been tried upon a limited number of printed documents (one die-printed letter heading and a number of letterpress printed bill headings) with positive results. It does not seem to be applicable to carbonized typewritten documents, and, since it would appear that the image may be produced by the reduction of nitrate silver, it is possible that the method is applicable only to those documents which have been printed or written with an ink containing a metallic constituent having reducing properties after incineration. Such inks would include the blue-black writing inks, and printing inks containing metallic driers.

Fig. 1.

RESULT OBTAINED WITH INFRA-RED RAY PHOTOGRAPHY.

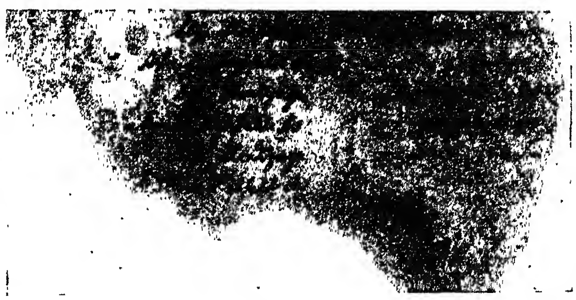


Fig. 2.

AFTER TREATMENT BY SUPERINTENDENT CHERRILL'S METHOD. THE REVERSED IMAGE ON THE RIGHT-HAND SIDE IS SHOWING THROUGH FROM THE BACK.

H. D. MURRAY.
20 Kinnerton Street,
Wilton Place, Knightsbridge,
London, S.W.1.
July 14.

[1] NATURE, 147, 417, 676 (1941).

CARRIER WEIGHTS OF CONJUGATED PROTEINS

By Dr. E. E. Broda and Dr. C. F. Goodeve, F.R.S.

University College, London

It has recently been observed[1] that the carrier weights, that is, the weight of protein carrying one gram-equivalent of prosthetic group, of a class of conjugated proteins, the chromoproteins, is in many cases equal to the Svedberg unit of about 17,600 gm. In no case is it appreciably less. Data for various conjugated proteins have since become available, and are shown along with the previous data in the accompanying tables. References for the latter data are given in the previous paper[1]. The carrier weights given include the weights of the prosthetic groups, and are therefore too high. The latter are, however, mostly unknown, but as they are certainly comparatively small (4 per cent in hæmoglobin, 1 per cent in the flavins) this error is not serious; moreover, the same systematic error is incurred in calculating the Svedberg unit from ultracentrifugal molecular weight determinations.

The new data confirm that the Svedberg unit is the lower limit of the carrier weights. Moreover, the tables show strikingly that all sufficiently well-defined compounds have carrier weights close to simple multiples of the unit, the 'permitted' carrier weights having the same values of the multiples, namely, 1, 1·5, 2, and probably 4, etc., as Svedberg[13] found for molecular weights. On account of their lower accuracy, conclusions concerning higher multiples appear premature. The existence of Group 1·5 is of especial interest in view of the fact that gliadin and hordein, two simple proteins, have molecular weights of 1·5 Svedberg units. These relationships provide new experimental evidence, *quite independent of molecular weight determinations*, to show the importance of the Svedberg unit.

CARRIER WEIGHTS (NUMBER OF GRAMS OF PROTEIN PER GRAM-EQUIVALENT OF PROSTHETIC GROUP).

Substance	Carrier weight R	Chemical nature of the prosthetic group (on which R is based)
GROUP 1:		
Hæmoglobin (horse)*	16,200	Hæme
Myoglobin (horse)*	16,200	An Fe compound
Erythrocruorin (Cyclostomata)	17,500	An Fe compound
Cytochrome C (horse, ox)*†	16,400	An Fe compound
Hæmocuprein (ox)*	18,700	A Cu compound
Hepatocuprein (ox)	18,700	A Cu compound
Laccase (*Rhus succedanea*)[2]	18,700	A Cu compound
Carbonic anhydrase (ox)[3]	19,800	A Zn compound
Carboxylase (yeast)[4]	18,700	A Mg compound
Thyroglobulin (man)[5]	18,100	An I compound
Average carrier weight: 17,900. Mean deviation from 17,600: 6 per cent. Greatest individual deviation: 12 per cent.		
GROUP 1·5:		
Hæmocyanin (*Helix pomatia*)	25,900	A Cu compound
Hæmocyanin (*Busycon canaliculatum*)*	25,900	A Cu compound
Hæmocyanin (*Octopus vulgaris*)*	25,400	A Cu compound
Hæmocyanin (*Loligo pealei*)*	24,400	A Cu compound
Conjugated protein (tyrosinase ?) from *Lactarius piperatus**[6]	24,500	A Cu compound
Average carrier weight: 25,200. Mean deviation from 1½ × 17,600: 4 per cent. Greatest individual deviation: 8 per cent.		
GROUP 2:		
Hæmocyanin (*Limulus polyphemus*)	36,700	A Cu compound
Hæmocyanin (*Homarus americanus*)	34,000	A Cu compound
Hæmocyanin (*Dromia vulgaris*)[7]	37,400	A Cu compound
Average carrier weight: 36,000. Mean deviation from 2 × 17,600: 5 per cent. Greatest individual deviation: 6 per cent.		

* Crystallized preparations.
† See, however, Theorell, *Science*, **90**, 67 (1939).

CARRIER WEIGHTS OF HIGH VALUE OR OF POORLY DEFINED COMPOUNDS.

Substance	Carrier weight R	Chemical nature of the prosthetic group (on which R is based)
Visual purple (frog)	< 26,500	(from photosensitivity)
Polyphenol oxidase (*Agaricus campestris*)	< 21,200	A Cu compound
Polyphenol oxidase (potato)	ca. 31,800	A Cu compound
Ascorbic oxidase (squash)[8]	< 41,000	A Cu compound
Phycocyan, Phycoerythrin	ca. 30,000	Phycobilin
'Old' yellow ferment*	70–80,000	Phosphorylated flavin adenin dinucleotid
Heart flavoprotein (pig)[9]	70,000	do.
Amino-acid oxidase† (sheep kidney)	< 87,000	do.
Milk flavoprotein[10, 11]	140,000	do.
Catalase (beef liver)[12]*	124,000	Hæme
Ovoverdin	144,000	Astaxanthene

* Crystallized preparations.
† Calculated below.

The molecular weight divided by the carrier weight obviously gives the number of prosthetic groups per molecule of protein. This may vary over a wide range; it is unity for cytochrome C and some of the flavoproteins, 4 for hæmoglobin, about 40 for thyroglobulin and 240 for hæmocyanin (*Helix pomatia*), etc. Clearly it must not be less than unity. On this fact was based an early method[14] of calculating minimum molecular weights of proteins long before the Svedberg unit was discovered.

Carrier weights of conjugated proteins, which dissociate into protein and prosthetic group, can be calculated for the state of suppressed dissociation. For example, for amino-acid oxidase the experiments of Warburg and Christian[15] can serve as a basis. The enzyme activity of the solutions containing varying quantities of protein and prosthetic group is proportional to the bound prosthetic group only. The activity of a solution containing $5 \cdot 4 \times 10^{-11}$ mol of the prosthetic group and a large excess of protein, that is, of a solution where practically the whole of the prosthetic group was bound, was 1·76 units, or $1 \cdot 76/5 \cdot 4 \times 10^{-11}$ units per mol. In another solution containing 2×10^{-5} gm. of protein and a large excess of prosthetic group, that is, in a solution where the protein was saturated with prosthetic group, the activity was 7·51 units and this solution must therefore have contained $\frac{7 \cdot 51}{1 \cdot 76} \times 5 \cdot 4 \times 10^{-11}$ mol of bound prosthetic group or 1/87,000 per gm. of protein. The carrier weight is therefore 87,000. As according to Warburg and Christian the protein was not quite pure, the true carrier weight may well come down to the value for the 'old' yellow ferment, that is, 70–80,000. An independent confirmation is provided by the result of Negelein and Brömel[16],

who found that reduction of the prosthetic group by alanin (which stops as soon as the bound prosthetic group is reduced because the reduction product sticks to the protein) proceeds only until one mol per 100,000 gm. of the (not quite pure) protein has reacted.

[1] Broda, E. E., Goodeve, C. F., and Lythgoe, R. J., *J. Physiol.*, **98**, 397 (1940).

[2] Keilin, D., and Mann, T., NATURE, **143**, 23 (1939).

[3] Keilin, D., and Mann, T., *Biochem. J.*, **34**, 1163 (1940).

[4] Green, D. E., "The Mechanism of Biological Oxidations" (Cambridge, 1940), p. 124.

[5] Pedersen, K. O., and Heidelberger M., *J. Gen. Physiol.*, **19**, 95 (1935).

[6] Dalton, H. R., and Nelson, J. M., *J. Amer. Chem. Soc.*, **61**, 2469 (1939).

[7] cf. Kubowitz, F., *Biochem. Z.*, **299**, 51 (1938).

[8] Lovell-Janison, P. L., and Nelson, J. M., *J. Amer. Chem. Soc.*, **62**, 1409 (1940).

[9] Straub, F. B., *Biochem. J.*, **33**, 787 (1939).

[10] Corran, H. S., Dewan, J. G., Gordon, A. H., and Green, D. E., *Biochem. J.*, **33**, 1694 (1939).

[11] Philpot, J. St. L., *Biochem. J.*, **33**, 1707 (1939).

[12] Sumner, J. B., and Dounce, A. L., *J. Biol. Chem.*, **127**, 439 (1939).

[13] cf. Svedberg, Th., and Pedersen, K. O., "The Ultracentrifuge", Oxford University Press (1940).

[14] See "containing weights", Cohn, E. J., *Physiol. Rev.*, **5**, 349 (1925).

[15] Warburg, O., and Christian, W., *Biochem. Z.*, **298**, 150 (1938).

[16] Negelein, E., and Brömel. H., *Biochem. Z.*, **300**, 225 (1939).

ETHNOLOGY OF THE LAU ISLANDS, FIJI

THE great interest held by the Lau islands for the ethnologist lies in the fact that they are situated between Fiji and Tonga, on the border where Melanesia and Polynesia meet. They had been subjected, therefore, to different impacts, both physical and cultural, even before the advent of Western civilization. For this reason the author of a recent paper* chose a group of islands in southern Lau which owing to its isolation and lack of valuable natural resources had been left comparatively untouched by Western influences, and on one of these, Kambara, she lived for five months making an intensive study of its culture. Owing to lack of time she was unable to devote much attention to material culture and concentrated rather on the social system as being more evanescent.

After a short account of the physical types and the geography of the island group, including a census of the chief village of Kambara, the author gives a full description of the social organization of the people. This is very complicated owing to the different influences that have impinged on the islands, but she has worked out the different social groups. The largest unit, the phratry, consists of groups of clans with the same mythical ancestor or group of ancestors. The clans are divided into subclans and these again into families or households. Through all these runs a deep-seated and elaborate system of rank ; not only each phratry, clan, subclan, family and individual, but also each village and chiefdom holds a different rank in the scheme. This is all clearly set out, and in subsequent sections marriage and relationship are discussed, followed by an account of the ceremonial usages and the economic life and material culture of the islands. The author also found time to excavate some archæological sites, principally fortresses on the various islands.

In her conclusion the author suggests that Lauan culture consists of three complexes : that of its own aboriginal (Melanesian) inhabitants, which is similar to that of the low Fijian culture of western Viti Levu. Some three hundred years ago, according to genealogies and tradition, a group of immigrants from eastern Viti Levu introduced a highly organized culture of a Polynesian type with a complicated system of rank, and they also increased production and developed industry to a high degree. The third impact came from the west with Tongan contact in the late "prehistoric" period. Its outstanding contributions were the concept of divine chieftainship with attendant ceremonial, of kava drinking and dancing, while on the material side came the introduction of the western Polynesian oval house and the technique of pasting tapa into long sheets. Thus Lauan culture is truly marginal and presents a unique fusion of Melanesian and early and late Polynesian complexes.

The bulletin is illustrated by maps, tables and photographs, and contains a bibliography and complete index.

* Bernice P. Bishop Museum. Bulletin 162: "Southern Lau Fiji: an Ethnography." By Laura Thompson. Pp. iii+228+5 pl. (Honolulu, 1940).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

THE South-Eastern Union of Scientific Societies has, for the second time, been obliged to curtail its annual congress to a single day of sessions and excursions ; this was held at Kingston-upon-Thames on July 26.

A representative assembly to transact the business of the seventy constituent societies was held during the forenoon, in the Queen Elizabeth Grammar School. Dr. W. E. St. Lawrence Finny, who has been mayor of the Royal Borough of Kingston no fewer than seven times, was elected president for 1941–42 ; in recent years he has served the Union as president of the Archæological Section.

"The Church of the Saxon Coronations at Kingston" was the title of Dr. Finny's presidential address. He described the ancient form of the Coronation Service, tracing its origin to the Court of Charlemagne, and showed lantern slides of such evidence as now exists of the church in which the Saxon kings must have been crowned. At Kingston the principal

exhibit is the original Coronation Stone of which the early history is unknown, but a coin is preserved showing Dubnovilaunus, a king of Kent, seated upon a stone of similar size and shape. Another local relic is a fragment of a Saxon commemorative cross bearing an interlaced design of a type not found elsewhere south of the Midlands. In the Lady Chapel of the Coronations there used to be fourteenth-century paintings of five of the Saxon kings crowned at Kingston as well as one of King John: it was the latter who gave the first extant charter to Kingston, the oldest of the three 'Royal Boroughs'—the other two being Windsor and Kensington. The original paintings upon wooden panels of these kings were accidentally discovered in 1813 during the renovation of Baston Manor House in Kent. One of these panels is now preserved in the hall of the Society of Antiquaries, and its Latin inscription gives conclusive proof that Athelstan was crowned at Kingston.

Dr. Finny's address had been preceded by separate sessions for business and the reading of sectional addresses, which will appear later in an abbreviated volume of the *South-Eastern Naturalist and Antiquary* (vol. 46).

The address to the Archæological Section was given by Edward Yates, on "The Early History of Hampton Court Palace". A feature of the Palace is the ease with which the buildings can be dated by the character of the brickwork and fenestration. The address to the Botanical Section was given by Dr. J. Ramsbottom, who spoke on "The Preservation of our Flora". The address to the Geological Section was delivered by Dr. R. L. Sherlock on "The Red Rocks as Indicators of Past Climates". In view of the Thames swan upping having been completed at Henley the previous day, it was appropriate that the presidential address to the Zoological Section should be by N. F. Ticehurst, upon "The Mute Swan on the Thames", illustrated with lantern slides of the old local swan-marks and upping ceremonies. Owing to lack of time, some further papers were taken as read. The Zoological Section papers had been prepared in the form of a *Bulletin* (No. 76). It includes a short paper by Miss Z. V. Waloff, of the Imperial Institute of Entomology, on "The Migratory Locust in the British Isles" and a "Preliminary Note on Dragonfly Migration" as an appendix to the annual report of the Insect Immigration Committee. The latter showed that the regular migration was upon a small scale comparable with that of 1937, and with a similar invasion of the large white butterfly, *Pieris brassicæ* L., the subsequent larvæ of which did considerable damage in market gardens (see *Entomologist*, 74, 54–62).

Dr. Finny conducted a party to Lovekyn's fourteenth-century chantry chapel and to other places of local antiquarian interest. Geologists went to Mickleham to examine fresh exposures in the Chalk recently cut for the Dorking by-pass road; a junction of the Middle and Upper Chalk here exhibits fossils of the *Terebratulina lata* and *Holaster planus* zones. R. V. Melville described the history of the Mole Gap and showed a fine swallow-hole near Mickleham Church.

No definite arrangements for the 1942 Congress were announced; but, in view of its jubilee, it was suggested that a suitable centre for an abbreviated Congress would be the Haslemere Educational Museum.

T. D.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 9: The Kinetics of the Polymerization of Isoprene on Sodium Surfaces. By J. L. Bolland. Pp. 20. Publication No. 10: The Proteins of *Hevea brasiliensis*, 2: Analysis of a Product isolated from Crepe Rubber. By G. R. Tristram. Pp. 4. (London: British Rubber Producers' Research Association.) [307

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 4, No. 10 (July–December 1940). Pp. ii+489–504. (London: Royal Meteorological Society.) 2*s*. 6*d*. [18

Other Countries

United States Department of Commerce: Weather Bureau. Monthly Weather Review, Supplement No. 44: Fifty Years' Weather in Kansas City, Mo., 1889–1938. By Andrew M. Hamrick and Howard H. Martin. (W.B. No.1316.) Pp. iii+53. (Washington, D.C.: Government Printing Office.) 20 cents. [307

U.S. Office of Education: Federal Security Agency. Pamphlet No. 93: Trends in Industrial Arts. By Maris M. Proffitt. Pp. iv+20. (Washington, D.C.: Government Printing Office.) 5 cents. [307

U. S. Department of Agriculture. Circular No. 600: Mortality of the Apple Maggot in Fruit held in Cold Storage. By P. J. Chapman and A. D. Hess. Pp. 10. 5 cents. Circular No. 602: Field Infestation by Insects that injure Rice in Storage. By W. A. Douglas. Pp. 8. 5 cents. Farmers' Bulletin No. 1566: The Sorghum Midge, with Suggestions for Control. Originally prepared by C. H. Gable, W. A. Baker and L. C. Woodruff, and slightly revised by E. V. Walter. Pp. ii+10. 5 cents. Farmers' Bulletin No. 1860: Gladiolus Diseases and Insects. By Lucia McCulloch and C. A. Weigel. Pp. ii+18. 5 cents. Technical Bulletin No. 774: Life Histories and Habits of some Grasshoppers of Economic Importance on the Great Plains. By Robert L. Shotwell. Pp. 48. 20 cents. (Washington, D.C.: Government Printing Office.) [307

Henry Lester Institute of Medical Research. Annual Report, 1940. Pp. 60+3 plates. (Shanghai: Henry Lester Institute of Medical Research.) [317

South Australia. Annual Report of the Director of Mines and Government Geologist for 1939. Pp. 6. (Adelaide: Government Printer.) [317

South Australia: Department of Mines. Mining Review for the Half-Year ended 30th June 1940. (No. 72.) Pp. 95. (Adelaide: Government Printer.) [317

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NATURE

SATURDAY
AUG. 23, 1941

WORLD MAGNA CHARTA

THERE could scarcely be higher tribute to the dramatic instinct and imaginative insight which led Mr. Churchill and President Roosevelt to choose the Atlantic for their historic declaration of peace aims than the fact that German commentators have already recognized and sought to minimize the parallel with the Fourteen Points. They at least have seen that this is no mere declaration of peace aims. It is a moral offensive which strikes Germany in one of her fundamental weaknesses—the dread and certainty of impending disaster.

Unsatisfactory as have been some of the recent debates on propaganda or political warfare, and slight the evidence that the Government was really alive to the value of the 'fifth arm' and prepared to integrate it into the general stragegy of the War, this master-stroke of the meeting and Declaration of the Atlantic provides convincing evidence that the important contribution to British defence and British strategy made by the Prime Minister in his speeches and broadcasts is now recognized. As a statement of peace aims, more could not be expected than is contained in the Declaration; less would scarcely have satisfied the bulk of those who were demanding a declaration of peace aims. Much more important, this clear enunciation of principles derived directly from the President's formula of the four freedoms is the starting-point for a moral and political offensive that will lead to the accelerated disintegration of Nazism. The peace offensive and initiative have passed into Anglo-American hands.

There have indeed already been welcome signs in recent speeches by Mr. Eden that in the field of political warfare Great Britain is no longer to remain on the defensive. In his speech at Leeds on July 6, Mr. Eden declared emphatically that the Government is not in any circumstances prepared to negotiate with Hitler at any time or on any subject. We would intensify our war effort until he and all he stood for was utterly destroyed. In the House of Commons a month later, on August 6, Mr. Eden reiterated the distinction between the military and the economic treatment of Germany. Every recourse that can be devised must be taken to see that Germany does not for a sixth time plunge Europe into war. There could be no wavering on that point although it would be to our disadvantage and to Europe's disadvantage that Germany should be economically ruined after the War. Mr. Eden went on to indicate that the Government had made certain changes in the work

for the co-ordination and for the operation of our political warfare, and that we were entering on a period of greater opportunities in this field.

The eight points of the Declaration made by the President of the United States and Mr. Churchill, representing His Majesty's Government in the United Kingdom, are as follows :

First, their countries seek no aggrandizement, territorial or other.

Second, they desire to see no territorial changes that do not accord with the freely expressed wishes of the peoples concerned.

Third, they respect the right of all peoples to choose the form of Government under which they will live ; and they wish to see sovereign rights and self-government restored to those who have been forcibly deprived of them.

Fourth, they will endeavour, with due respect for their existing obligations, to further enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are needed for their economic prosperity.

Fifth, they desire to bring about the fullest collaboration between all nations in the economic field, with the object of securing for all improved labour standards, economic advancement and social security.

Sixth, after the final destruction of Nazi tyranny, they hope to see established a peace which will afford to all nations the means of dwelling in safety within their own boundaries, and which will afford assurance that all the men in all the lands may live out their lives in freedom from fear and want.

Seventh, such a peace should enable all men to traverse the high seas and oceans without hindrance.

Eighth, they believe all of the nations of the world, for realistic as well as spiritual reasons, must come to the abandonment of the use of force. Since no future peace can be maintained if land, sea, or air armaments continue to be employed by nations which threaten, or may threaten, aggression outside of their frontiers, they believe, pending the establishment of a wider and permanent system of general security, that the disarmament of such nations is essential. They will likewise aid and encourage all other practicable measures which will lighten for peace-loving peoples the crushing burden of armament.

This unequivocal declaration regarding Nazism deals the first blow in the political offensive for which Sebastian Haffner calls in his book "Offensive against Germany". While waging war with all our strength, we are giving it a purpose which makes resistance on the enemy's part superfluous and impossible. The most cursory reading of the Declaration of Mr. Churchill and President Roosevelt, with its reference to the final destruction of Nazi tyranny and the pledge to endeavour, with due respect for existing obligations, to further the enjoyment by all States, great or small, victor or vanquished, of access on equal terms to the trade and raw materials of the world, which are needed for their economic prosperity, indicates how well the opportunity has been grasped.

Here at long last Anglo-American co-operation is fashioning weapons for a moral offensive, perfecting the technique and tactics of effective propaganda. Here is the break with the wavering policy of the last ten years, and the creation of a policy giving full power to propaganda, confronting the misery and slavery of the Nazi New Order with an equally tangible but nobler New Order. Here is the formulation of our cause in terms which should make it an irresistible moral weapon.

No better answer could indeed be given than the Declaration of the Atlantic to Nazi and Fascist attempts to represent the War as a conflict between the large and proper ambitions of young and vigorous races and the unimaginative selfishness of two democracies that have lost the capacity for leadership. The dramatic setting is well calculated to carry the generous spirit of the principles embodied in the Declaration across the frontiers and into the hands of every country that lies under the Nazi yoke. Here is the testimony that Great Britain has accepted the formula of President Roosevelt, that it has turned its back on the world of 1939 and is prepared to make the sacrifices involved in the establishment of the four freedoms and the pursuit of the constructive economic policy by which alone the world can be made free from fear and free from want.

The Declaration does not propose to set up a world in which a man will have a privileged position because he is British or American. On the contrary, in the world contemplated he may be asked to make real sacrifices of national interest or prestige, and from this fact alone the declaration derives immense value, both for the prosecution of the War and for the settlement of the world thereafter. There is nothing in the terms of the document which has not already figured in the speeches of British and American statesmen. President Roosevelt's great speech upholding the four freedoms is not more pertinent in this connexion than the Prime Minister's refusal even in our darkest hour last summer to abate one jot of our commitments to restore liberty to those peoples who have been deprived of it, or Mr. Eden's recent insistence that peace must not bring destitution even to the guilty. It is the formal recognition of such aims and principles, the assumption by the United States and the British Empire of a joint responsibility for all that is implied in the establishment of such a peace, and the definite association with those aims and principles of the destruction of Nazi oppression and the disarmament of the

aggressor nations, and the enactment of measures to secure peace and order while leading ultimately to collective disarmament, which give the declaration the force of high explosive in the hands of friends of liberty in all the oppressed countries.

"Here in Britain," said Mr. Eden, on July 6, "we must lay the foundations of a new Europe, at meetings of the Allied Governments", and the forthcoming meeting will acquire fresh inspiration and value from this demonstration not merely of American association with that task, but also that the Government is imaginatively alive to the possibilities and opportunities of fashioning the future of men's hopes amid the sights and sounds of war. On the wide waters of the Atlantic and this free soil of Britain, the forces of freedom are being marshalled, and the Declaration affords reasonable assurance that the future peace settlement will not fail because it either lacks large and bold economic imagination, or makes too little provision for safeguarding Europe from another outburst of aggression. Not again can Britain and the United States take too lightly their duties of order and peace.

The eight clauses of the Declaration deserve and should receive the closest study. Even at a first glance, their resemblance to principles already enunciated by many responsible studies of the central problem of Germany and European order—as, for example, the conclusions of the recent broadsheet issued by Political and Economic Planning (P E P) on "The Future of Germany"—is as remarkable as the harmony of the whole circumstances in which the Declaration was made with the conditions of a moral offensive, as indicated by Sebastian Haffner, or by Mr. Wickham Steed in recent letters in *The Times*. The hopes the Declaration will inspire in Europe are well founded, because here at last is clear recognition of the twin and inescapable conditions of any true peace—the provision of real incentives to observe it and real deterrents against breaking it.

It has been clear for months past that both in Great Britain and in the United States it is increasingly recognized that the economic foundations of peace are as important as the political, that vanquished and victors will have to live together in the world of to-morrow, and that a rising standard of living, such as a well-ordered world can furnish, will be one of the indispensable guarantees of security and the permanent answer to the more specious elements of the Nazi and Fascist appeal. That is the fundamental conception which has inspired the work of the Leith-Ross Committee, the Willingdon Commission or the agreements in regard to shortages and surpluses concluded last June between the United Kingdom and the Dominions of Australia and New Zealand. Its embodiment in this Declaration, the establishment of freedom from fear and want as a world objective, should give fresh purpose and incentive to all such efforts and movements.

No less emphatic is the fifth clause, affirming the desire to "bring about the fullest collaboration between all nations in the economic field with the object of securing for all improved labour standards, economic advancement, and social security". That affirmation should give fresh heart to the many already concerned in dealing with the technical problems involved, and should lend fresh purpose to the meeting of the International Labour Organisation already contemplated this autumn. The solemn exclusion of arbitrary territorial changes and of territorial and material ambitions from our war aims is reaffirmed, and recognition of the right of all peoples to choose the form of government under which they will live is repeated, as well as the affirmation of our desire to see sovereign rights and self-government restored to those who have been deprived of them.

The means by which these principles are to be translated into practice have still to be worked out, but already much machinery lies to our hand for the task. The Declaration, as already suggested, gives new importance to the meetings of the Allied Governments in London. In that embryonic conception of a free united Europe, of a European cabinet, must be worked out the mechanism by which the choice of form of government for the occupied and enemy territories must be devised, so that the suppression of liberties in one country is never again allowed to threaten the liberties of others. The addition to those meetings of free German representatives from among the many distinguished German émigrés already to be found in Great Britain, parallel with the Free French representatives, might well supply the vital touch, particularly in the formulation of the strategy and tactics of political warfare on the increasingly offensive scale which the Declaration should rightly inspire.

These are but a few of the consequences which should follow from this historic meeting and Declaration. Gratitude to President Roosevelt for suggesting the meeting and to Mr. Churchill for his instant response, and admiration for the dramatic sense and timing of both meeting and Declaration, will not be the less for the further indication it affords of growing Anglo-American co-operation, and of readiness to accept the full responsibilities of world leadership and all that such responsibilities involve. The courage and imagination which have been displayed are the best assurance that the world will not look in vain to Great Britain and America to provide the leadership and resources adequate to establish the world order outlined in this historic Declaration.

BERTRAND RUSSELL ON MEANING AND TRUTH

An Inquiry into Meaning and Truth
By Bertrand Russell. Pp. 352. (London: George Allen and Unwin, Ltd., 1940). 12*s*. 6*d*. net.

BERTRAND RUSSELL is the Picasso of modern philosophy. He has expressed himself very differently at different periods; and in each period he has exerted deservedly great influence and aroused extravagant hostility. That his works have always produced so strong a reaction is partly due to the sharpness and clarity with which they have been written. But this, unfortunately, does not hold good of his latest book, which differs not so much in its subject matter as in its style from anything that he has written before. It deals in a comprehensive, if unsystematic, way with the class of philosophical problems that are conventionally brought under the heading of the theory of knowledge. Many interesting questions are raised by it and ingenious answers suggested. But the argument as a whole suffers from a hesitancy and discursiveness which make it unexpectedly difficult to follow.

Though he is inclined to drop hints about the limitations of empiricism, Russell still in the main approaches his problem from an empiricist point of view. He says that he is, "as regards method, more in sympathy with the logical positivists than with any other existing school," but he rightly rejects the formalist view, which Carnap and others of them have put forward, that no more is ever necessary for the specification of a language than an account of its syntactical rules. He recognizes that if we are to make statements which can be empirically true or false, we require not merely the formal rules which correlate symbols with one another, but also rules of meaning, which correlate symbols with observable facts. His way of making this point is to take, as what he calls his language of lowest type, "a language consisting wholly of 'object words', where 'object words' are defined, logically, as words having meaning in isolation, and, psychologically, as words which have been learnt without its being necessary to have previously learnt any other words." That he is thinking here of words that are defined ostensively is shown by his further explanation that "an object word is a class of similar noises or utterances such that, from habit, they have become associated with a class of mutually similar occurrences frequently experienced at the same time as one of the noises or utterances in question." At the outset he claims for his object language only that it is one among a number of possible languages of lowest type; but this must not be taken to imply that he conceives himself to be engaged merely in a game of language building. For sentences of the object language are apparently supposed to express what he calls basic propositions, where, by a basic proposition, he means one that "arises on occasion of a perception which is the evidence for its truth"; and he holds that these basic propositions constitute the indispensable foundation of all empirical knowledge. They fulfil this function in virtue of their connexion "with certain non-verbal occurrences which may be called experiences"; and the nature of this connexion is, for Russell, "one of the fundamental questions of epistemology". He implies, indeed, that it is for him the essence of the problem both of meaning and of truth.

In the case of meaning Russell falls into confusion through taking it for granted that meaning is a relation which somehow connects a symbol with some sort of object. Thus he assumes that "when a sentence is significant, there is something that it signifies"; but "since a significant sentence may be false, it is clear that the signification of a sentence cannot be the fact that makes it true (or false). It must therefore," he concludes, "be something in the person who believes the sentence, not in the object to which the sentence refers." This "something" he chooses to call a proposition, defining propositions as "psychological occurrences of certain sorts, complex images, expectations, etc." But this whole line of reasoning is surely mistaken. To ask what a symbol signifies is legitimate if what is required is an explanation of the way in which it is used. In the case of any given sentence such explanations may take the form of translating it into other sentences, the meaning of which is assumed to be known, or of describing the sort of situations to which it is conventionally applied. But this course cannot be followed when the question about the meaning of symbols is completely generalized, for the reason that there is no general usage to explain. There is no one thing that all symbols mean.

It is true that the assertion of sentences may be accompanied by complex images, expectations and so on: but it is very misleading to say that these are in any sense what the sentence means. Similarly, it is true that the expression of a symbol which describes a sensible occurrence is usually in some way an effect of the occurrence in question. But this does not justify one's defining the meaning of the symbol in terms of the causal relation, as

Russell is inclined to do. It is an old philosophical fallacy to suppose that a symbol must have some natural connexion with that which it symbolizes, apart from the conventional rules by which its use is determined. The establishment of these rules does, no doubt, depend on physical and psychological factors, which can be investigated; but these factors do not enter into the definition of the rules themselves.

In the case of truth, Russell hesitates between two versions of the correspondence theory, the 'logical' version, according to which propositions are required to correspond with 'facts', and the 'epistemological' version, according to which they are required to correspond with 'experience'. He eventually decides in favour of the logical version, principally upon the ground that it makes it possible to retain the law of excluded middle, whereas he thinks that, according to the epistemological version, propositions which there is no practical means of verifying must be regarded as neither true nor false. Unfortunately he does not make it at all clear what he intends us to understand by 'fact' as opposed to 'experience'. It depends upon his theory of perception, of which no clear or consistent account is given in the book. In the main, he seems to adhere to a causal theory, according to which sense-data, which are absurdly described, in one place, as "states of ourselves", and in another, as being "inside the percipient's head", are conceived to be the effects of physical events which are themselves unobservable. But he does not try to meet the main objection to all theories of this type, which is that the notion of causality has no significant application outside the field of possible experience. Throughout the whole book, indeed, he makes use of causal relations in a surprisingly uncritical way.

The fact is that, while Russell appears to start from an empiricist position, he does not consistently adhere to it. This is shown, among other things, by his analysis of the use of words like 'this' and 'I', which he calls egocentric particulars. His view is that their peculiarity lies not in their meaning but in their causation, inasmuch as the expression of them is the effect of a "minimal causal chain", which, "in this connection, is the shortest possible chain from a stimulus outside the brain to a verbal response". He concludes that words of this kind are "not needed for a complete description of the world", whatever that may be. But this is to assume that the public physical world is in some mysterious way impersonally 'given', and that the question is to fit the egocentric particulars in; whereas in fact it is just the other way round. Epistemologically, it is necessary to start with the individual's private experience, in the description of which egocentric particulars cannot be dispensed with. Russell does indeed recognize this in the case of "our knowledge of other minds", which he treats as a problem of explaining one's knowledge of events that one cannot oneself directly verify. He takes as an example the proposition "you are hot", which he says is roughly equivalent to, "there is a hotness related to my percept of your body as, when I am hot, the hotness of me is related to my percept of my body". He then remarks that whereas "when I am hot, I can give a proper name to my hotness; when you are hot, your hotness, to me, is a hypothetical value of an apparent variable." But this, according to him, is simply a matter of the insufficiency of my vocabulary. "It is a merely empirical fact that I have not sufficient proper names for this purpose."

I believe this answer to be along the right lines, but it will scarcely do as it stands. For if the fact that I cannot directly verify statements about other people's experiences is simply due to the accidental limitation of my vocabulary, what is there to prevent me from removing this limitation simply by inventing new proper names? The answer is that, however inventive I am, the proper names that I add to my vocabulary will always refer to elements of my own and not of anybody else's experience. For the fact that each person's experience is private to himself is logically necessary. It is so, however, only in the sense that it depends upon the conventions that we have chosen to adopt in speaking about people's experiences: and the facts which make it useful to adhere to such conventions are indeed empirical. As we now use words, it is impossible, even in principle, for one person literally to share another's experiences; but it is not difficult to imagine circumstances in which we should find it convenient to adopt a different verbal usage.

Perhaps it is considerations of this kind that lead Russell to say, at the end of his book, that he believes it possible to make inferences "from the structure of language as to the structure of the world". He tells us indeed that the proof of this possibility "has been in a sense the goal of all our discussions". But if he intends this to be taken seriously, he seems to me to be setting too low a value on his book. For if he means only that the development of a language is partly conditioned by the nature of the facts which it is used to describe, his conclusion, though true, is not one that it would take a lengthy book to prove; while if he is referring to some more mysterious affinity between language and the 'world', it does not appear to have been established by anything that he has previously said.

A. J. Ayer.

THE MAKING OF THE 'MARITIMES'

The Cod Fisheries
The History of an International Economy. By Harold A. Innis. (The Relations of Canada and the United States: a Series of Studies prepared under the direction of the Carnegie Endowment for International Peace, Division of Economics and History.) Pp. xx+520. (New Haven, Conn.: Yale University Press; Toronto: The Ryerson Press; London: Oxford University Press, 1940.) 21*s*. 6*d*.

THIS is an important book (as well as a large one) about the great fisheries of the maritime provinces of North America, including New England, tracing their history from the days of Cabot's discovery of Newfoundland to the recent inglorious submission of that island to administration by British civil servants.

The book is one of a series designed to promote the mutual understanding of Canada and the United States. It is also introduced as a challenge to the imagination and insight of the reader, which it undoubtedly is, and Canadian and American students who master it may well have a fellow-feeling based on survival of the same ordeal, for it is uncommonly hard reading.

Yet the book is saved by its very pedestrianism. It is a long and tedious tale of petty greed and sectional interests, in which it is usually the reader who has to contribute the thought that these men were venturing their all, or their lives, on arduous fishing in comfortless places, and in far voyaging with the catch to West Indies and Mediterranean; but there is a fascination in the record of commercial facts which passes across the pages with the precision and inevitability of the tape-machine: "Colonial shipping grew in importance with colonial trade. In 1763 St. John's shipped fish totalling 56,365 quintals. Of this, vessels from Philadelphia carried 2,967 quintals"; etc.; or, from a footnote: "Planters increased from 346 men in 1736 to 690 in 1747, and to 1,250 in 1764; servants from 3,727", etc.

There is another and greater virtue in the book, in that it does attempt to make sense of all this, to show the historical trends that have resulted in the present state of affairs in the Maritimes. Despite the long record of apparently unimportant detail, the author does establish his right to draw sweeping and important conclusions. Having traced the failure of the chartered company system, then the dominance of the English West Country Merchant Adventurers, whose power was destroyed by the multitude of small settlers, and the rise of their commerce, essentially a maritime decentralized economy, he shows how this in its turn has fallen.

"The transition from dependence on a maritime economy to dependence on a continental economy has been slow, painful, and disastrous. The tremendous initiative which characterised commercialism based on the fishing industry could be measured in the collapse of West Country company control over trade and the fishery, in the history of Newfoundland and New England, the defeat of France and the breakdown of the colonial system, the disappearance of the Navigation Acts, and even the rise of responsible government and the establishment of Confederation. This is an initiative which cannot be suddenly replaced. The effects of the tragedy of the replacement of commercialism by capitalism call for a long period of expensive adjustment and restoration, and this cannot take place without policies which foster the revival of initiative under responsible governments."

Those are Prof. Innis's closing words. As English I found the passage difficult, but unless I am much mistaken it is history of the most useful kind—that understands the past in order to forgive the present, and prepare for the future.

MICHAEL GRAHAM.

ANIMALS AND PLANTS AT HOME

The Open Book of Wild Life
An Introduction to Nature Study. By Richard Morse. Pp. 240+48 plates. (London: Adam and Charles Black, Ltd., 1941.) 8*s*. 6*d*. net.

MR. MORSE's book is meant primarily for younger readers, but it is not likely that many adults will begin reading it without being caught by its irresistible charm—the charm of the wild life of the British countryside and the charm of the writer's style. The book is based on sound scientific principles, and compresses an enormous amount of knowledge in a comparatively small compass. In fact, everybody can learn something from what one can only describe as a delightful book. It is not a text-book. It comprises the

observation and thoughts of a true lover of Nature. There is no evidence of any attempt on the part of the author to teach natural history (much less biology) to his readers. He proves himself here to be a literary "Zoo-man" or "Romany", telling his readers, as David Seth-Smith writes in his foreword, "in simple language, what to look for, and how to make one's country walks much more interesting than they have ever been before".

Thus he tells his readers a great deal that they will not find in their more formal text-books, and, indeed, he tells much that the text-book does not even explain, which is all to the good. It will set an enthusiastic reader wondering, and, above all, verifying by practical observation.

Even so, though the author does not attempt to teach biology in the formal way, his own style of presentation brings out the main biological principles almost surreptitiously. For example, after a fascinating account of the behaviour of the adult and young cuckoo (where he introduces the concept of instinct) he finishes :

"As soon as any plant or animal begins to steal from others instead of working for itself, it begins to lose some of its organs or some of its powers. It begins, in other words, to degenerate. Now the cuckoo affords a striking illustration of the working of that law, for it is quite plainly a degenerate bird. It is, for example, very unsociable—just the opposite of the highly intelligent rooks. Then again, the mother cuckoo, as we have already seen, cares nothing at all for her children, and she is herself a terrible glutton. How amazingly different she is from the pair of little blue-tits who brought home two thousand grubs and caterpillars for their young ones in a single day—a task which meant at least sixteen hours of almost continuous labour !

Exactly how the cuckoos first came to start their life of indolence and plunder nobody knows, but it is quite evident that they are birds that are going downhill. Their eggs are peculiarly small ; their internal organs are always in an unhealthy condition ; and they are hated and despised by vast numbers of their hard-working fellow-birds."

Few other books of this standard would put it like that.

Mr. R. Morse, Mr. Eric J. Hosking, Miss C. von Wyss, Mr. W. S. Berridge, Mr. D. Ferguson and Mr. C. A. Hall are all well-known nature photographers, and there are nearly fifty of their photographic studies reproduced here, together with some others. The fifty beautiful line drawings are by such well-known nature artists as Miss Doris Roger, Miss C. von Wyss and Mr. Roland Green. Some of the sixteen colour plates are particularly attractive, especially Roland Green's "Ruler of a Kingdom" (robins at home) and V. R. Balfour-Browne's "Our Largest Wild Animal" (red deer).

If this book achieves the success that it so richly deserves, it will be more to the advantage of its young and adult readers than to the author, who is deserving of praise and congratulation for such a charming and valuable contribution to popular scientific literature.

FARMING AND NATIONAL LIFE

England and the Farmer

A Symposium by Viscount Lymington, Sir Albert Howard, C. Henry Warren, Adrian Bell, Rolf Gardiner, Dr. L. J. Picton and Prof. Sir George Stapledon. Collected and edited, with an Introduction, by H. J. Massingham. Pp. vi+154+81 plates. (London : B. T. Batsford, Ltd., 1941.) 10*s*. 6*d*. net.

IN this book Mr. Massingham has collected a series of essays by well-known agricultural writers mostly belonging to the same school of thought, and he thus gives them an opportunity of restating their views on farming in relation to national life in Britain. In the main, they support what he calls the "Rule of Return", that is, the rehabilitation of the small yeoman farmer, the return of all waste products to the land, the avoidance of imports and the elimination of 'big business' ; and it is recognized that this involves a "return to smaller units of social economic life and the splitting up of the swollen topheavy communities squeezed into huge towns".

The advantages of small-scale general farming on our own soil, it is claimed, are so overwhelming that one wonders why it has not prospered here. Lord Lymington criticizes our present methods and states that "subnormality in health and degenerative disease are the average in this country" and this can only be cured by a general return to the land. Sir Albert Howard's solution is a more widespread adoption of the Indore method of making compost, which is based on the wisdom of the East : "in the Orient a fertile soil always means healthy crops" ; we should, he says,

retrace our steps and discard the use of artificial fertilizers "which history will condemn as one of the greatest misfortunes which has befallen agriculture and mankind". Facing this page is a good photograph showing the application of artificial manures in preparation for wheat on what looks like a very well-run farm.

Mr. Warren recognizes that we must continue to import corn but must also continue to grow it, and he argues in favour of a subsidy for keeping land in good heart rather than for particular crops. Mr. Rolf Gardiner gives a spirited account of the self-contained estate, which is a better unit than the self-contained farm, being larger and more comprehensive; but he cites no example that he can commend although several landowners have actually tried this method. Sir George Stapledon makes some calculations showing what might be achieved if the grassland of Great Britain were fully improved. Mr. Adrian Bell claims that the small family farm maintains the highest standard of fertility, yet admits that the sons try to get away from it.

That brings us at once to the crux of the problem. You may argue as much as you like with a young countryman about the joys of a peasant's life (which you are obviously not leading yourself), of the delight of working in the field from morning until night, of walking behind the plough, of swinging the scythe, etc. He is not interested. His idea, if he stays on the land at all, is to drive a tractor and let *that* do the work, to have a short day and abundance of leisure. It is unfair to blame the system of education for this; the responsibility is with the motor-cycle and the motor-bus, that take the young countryman into the town and show him how the machine and the scientific appliance can shorten the day's labour and at the same time increase the day's output. This has been the direction in which our agriculture has moved, thanks to science and engineering, and it has given our farm workers a higher output, better remuneration and easier conditions of life and labour than any others in Europe.

But the picture has another side; the output per acre in Britain has been low. In a general way there is often an inverse relation between output per man and output per acre, but this is not essential; and the great problem confronting British agriculture now is to raise the output per acre while maintaining or increasing the output per man, and it should be possible to do this without going back to peasant conditions.

E. J. RUSSELL.

SUGAR REFINING

Technology for Sugar Refinery Workers
By Oliver Lyle. Pp. 401. (London: Chapman and Hall, Ltd., 1941.) 15s. net.

THIS book gives a comprehensive account of the manufacture of refined from raw sugar. The author apologizes for his frequent reference to the refinery at Plaistow Wharf, but the apology is unnecessary since the author's experience at that factory gives him the opportunity of tracing the development of the industry during many years.

Short chapters are devoted to chemistry and physics in so far as these subjects are related to sugar refining. Full descriptions are given of steam boilers, electrical plant, pumps, evaporators and vacuum pans used in the refinery and there are detailed accounts of the successive stages of refining—filtration, char treatment, evaporation, boiling to grain, etc.—and of the methods of systematic control of the factory efficiency. In the refining process as carried out at the Plaistow Refinery, the total loss of sugar during a recent six-months period was only 0·7 per cent, a figure which speaks volumes for the efficiency of modern refining especially in view of the fact that most of the sugar is turned out as refined sugar of 99·9 or 99·95 per cent purity. The technical part is followed by an account of the transactions involved in the buying of raw sugar and sale of the refined article.

Very few mistakes have been noted in the text and only two are serious enough to warrant mention. On p. 72 it is stated that of the two rays into which light is separated by Iceland spar, one is plane-polarized and the other is ordinary light; actually, of course, both rays are plane-polarized at right angles. On p. 106 it is stated, in effect, that coal differs from wood and vegetation only in having undergone compression!

The author makes a very justifiable protest against the claim that glucose is preferable to sucrose as a food; this claim, developed in the first instance by advertisment, has unfortunately been accepted by many medical men.

The book is well printed and the illustrations are numerous and excellent.

LEWIS EYNON.

Bainbridge and Menzies' Essentials of Physiology

Ninth edition, edited and revised by Prof. H. Hartridge. Pp. x+687. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1940.) 16*s*. net.

"BAINBRIDGE AND MENZIES" first appeared in the early days of the War of 1914–18. It rapidly made headway and now rightly holds place as one of the standard text-books for the teaching of physiology. This, the ninth, is the fourth edition for which the present editor has been responsible.

Although this new edition has not demanded the extensive changes in subject-matter apparent in the last, the introduction of a considerable amount of new material has still been necessary. Nevertheless Prof. Hartridge has retained the same limits of length and size, a task which must have entailed laborious detail in revision. He has, further, continued the same plain method of presentation in distribution of content, in paragraphing, in type of illustration and in make-up generally, laid down by the original authors.

The book suffers from the defects of its title; indeed it always has. For the limits of its mere length impose mechanical restrictions calling for careful selection in the compression of material and in the proportionate balance given the different chapters. This is, of course, a problem which all technical writers, and in particular, teachers, have to face. In the present instance the aim of keeping "Bainbridge and Menzies" within the imposed limits has been carried too far. Both the standing and purpose of the book would well justify an expansion sufficient to allow a better balance and freer discussion. Physiology to-day is a different thing from what it was in 1914; it is scarcely reasonable to expect a volume of the same size to contain the subject as completely.

The Anatomy of the Eye and Orbit

Including the Central Connections, Development, and Comparative Anatomy of the Visual Apparatus. By Eugene Wolff. Second edition. Pp. x+374. (London: H. K. Lewis and Co., Ltd., 1940.) 31*s*. 6*d*. net.

THIS book makes a bid for a unique position both in ophthalmology and anatomy; it is easy to understand why a second edition has so soon been called for.

The subject-matter apparent in the title is fully and generously covered, the bony orbit and the eyeball, the appendages and the musculature, the vessels and the visual pathway. Mr. Wolff adds to the value of his book by his chapters on development and comparative anatomy; the latter is indeed, if choice may be expressed, one of the most attractive in the book.

The text is clearly and concisely written, seeking always a simple statement of fact, a property too often lacking in technical books; the account, for example, of the development of the iris and of the knotty problems concerned with that of the vitreous could scarcely be bettered. The neurological descriptions may also be remarked on.

Many of the numerous illustrations are original and some are really admirable; the drawings by A. K. Maxwell from sections by the author of Verhoeff's membrane may be cited as an example.

References are full and complete, and the book is well indexed.

The Calculation and Design of Electrical Apparatus

By Dr. W. Wilson. Third edition, revised. Pp. xv+240. (London: Chapman and Hall, Ltd., 1941.) 10*s*. 6*d*. net.

NO author could have had better press notices of a book than has Dr. Wilson of the earlier editions of this one and, as a natural corollary, one might say that the book has deserved every word of them.

The new edition contains additional matter and is not simply a reprint of the previous one. The two chapters on heating and fusing and on the calculation of heavy conductors have received most attention in the revision, more complete data being given on the calculation of convection and radiation losses, temperature conversion factors, time-constants, short-time ratings and conductor emissivities. In the chapter on system short-circuits a method is now given of finding the asymmetric factor and the duration of the D.C. component of asymmetric waves.

So far as heavy conductors are concerned, additional charts are included for the estimation of skin and proximity factors for bars, rods and cables, and the sizes of rectangular single and laminated bus-bars can now be ascertained by rational calculation instead of by semi-empirical methods.

Other miscellaneous data and worked examples are provided, all of which increase the value of this very acceptable book. S. A. S.

General Biology

By Prof. James Watt Mavor. Revised Edition. Pp. xxx+897. (New York: The Macmillan Company, 1941.) 4 dollars.

THE absence of a really coherent course in biology for students of general degree standard in Great Britain is probably one of the reasons for the dearth of good British text-books as compared with a large number of different American texts of which the book now before us is one of the best examples. It can be strongly recommended for the keenest students of Higher School Certificate standard, but more so should it be brought to the notice of all teachers of biology, no matter of what standard.

The book was published in 1936 and was such a success that it was necessary to reprint it five times; but the present edition is a totally new one. The pages have been increased in size and their number has been advanced by about one-sixth, with a corresponding increase in number of illustrations. The latter increase is due largely to the incorporation of a number of excellent photographs.

The author also presents a suggested schedule for a thirty-week course of practical laboratory work for the use of teachers, who are often sadly in need of guidance and who usually lack enough initiative to depart from the deadly 'type' system imposed by the prevailing examination system.

Introduction to Algebraic Theories

By A. Adrian Albert. Pp. viii+137. (Chicago: University of Chicago Press; Cambridge: At the University Press, 1941.) 10*s*. 6*d*. net.

PROF. A. ADRIAN ALBERT is well known for his outstanding research in algebra and, in particular, the structure of non-commutative algebras. His "Modern Higher Algebra", published in 1938, presented the first English text of modern algebraic theories on a purely abstract basis. In the meantime, he has been concerned with the obviously serious gap existing in the mode of thought between the intuitive treatment of the theory of equations and the essentially rigorous and abstract methods of the "Modern Higher Algebra". In spite of the attempt to bridge the gulf by the publication of several more abstract presentations of the theory of equations, Prof. Albert felt that the only satisfactory course was to provide a new introduction to algebraic theories, and the present volume is the result.

The text begins with polynomials and then passes to a full discussion of the theory of matrices with simple modern proofs. The six chapters are written with great clarity and are well illustrated by many new types of numerical exercises. The last chapter—on fundamental concepts—is a noteworthy and illuminating introduction to the study of abstract algebra. Any student who has a good knowledge of the usual theory of equations and of determinants will be able to follow the course without difficulty. To those interested in the application of the theory of matrices to statistics, economics and psychology, this book should also be very useful.

Embryology of Insects and Myriapods

The Developmental History of Insects, Centipedes and Millepedes from Egg Deposition to Hatching. By Prof. Oskar A. Johannsen and Ferdinand H. Butt. (McGraw-Hill Publications in the Zoological Sciences.) Pp. xi+462. (New York and London: McGraw-Hill Book Co. Inc., 1941.) 35*s*.

WITH the growth and rise of the modern subject of experimental embryology, renewed interest has asserted itself in regard to the 'normal' developmental phases of animals. The resulting demand is likely to be for more exact studies of the development of individual organs and parts. In this connexion the re-investigation of their intimate origins, cell by cell, seems likely to be called for. In so far as insects are concerned, the experimental aspects of their development have not, as yet, progressed very far, and at this stage a stock-taking of the position as regards the general embryology of these animals is opportune. This has been provided for in the new book by Messrs. Johannsen and Butt, who have restated the modern position of the subject in a clear and readily understandable style. Both authors have published original researches in embryology which qualify them for this task. Their work is one of judicious compilation and the unbiased assessment of conflicting views: in both these respects it has been ably accomplished.

The book is divided into two parts, of which Part I is a general comparative account of the development of insects and myriapods. This part also includes a useful chapter on experimental embryology, based on a review of the subject by Richards and Miller, published in 1937. Short chapters on polyembryony and parthenogenesis and on micro-organisms in the egg are also included. In Part II the embryology of leading types of the different orders is described. Thus, for the Orthoptera the work of Roonwal on Locusta is freely drawn upon both for figures and textual matter. For the Coleoptera the junior author's account of the weevil Brachyrhinus forms the basis, and for Scolopendra, Heymon's well-known memoir provides the necessary data. These several accounts contain very adequate illustrations and at the end of the book there is a bibliography of more than 700 references.

The letterpress is well up to date, and it is pleasing to see so much attention paid to the findings of recent research. By way of criticism certain features require mention. The account of the Myriopoda is disappointing on the whole, especially with reference to the Diplopoda. Also, the authors' attention is invited to their use of unfamiliar group names such as Oligoentomata, Aptilota and Oligonephridia, which are left undefined and are likely to confuse the student. These are minor blemishes in a thoroughly sound text-book. A. D. IMMS.

The Tutorial Algebra

By Dr. William Briggs and Prof. G. H. Bryan. Fifth edition, revised and re-written by Dr. George Walker. Vol. 1: Intermediate Course. Pp. xv+457. (London: University Tutorial Press, Ltd., 1940.) 7*s*. 6*d*.

THIS is the fifth edition of a well-known book written originally as a text-book for students taking the London intermediate and degree examinations. In consequence of the many changes which have taken place in the mathematical syllabuses prescribed for these examinations, as well as the improvement in teaching methods, it became necessary to revise completely and extend the scope of this work. It has thus been expanded into two volumes of which the book under notice is volume 1.

This covers all the algebra required for the London intermediate examinations except that for economics. It begins with the theory of indices and elementary ideas of complex numbers. The usual course is then followed up to the binomial theorem, interest and annuities. The sections devoted to equations are especially noteworthy and comprehensive. Particular stress is rightly laid on the functional notation and attention is early directed to the properties of partial fractions. Exercises in abundance, with answers, are supplied for the student's practice, and many of these have been taken from recent examination papers. Special emphasis has been laid on the diversity of types of examples, and a large number have been fully worked in illustration of the text.

The book is very attractively bound and the printing is very clear. It should prove very useful to students of algebra whether reading for the relevant examinations or not.

DEVELOPMENT OF HEAVIER-THAN-AIR CRAFT

By The Right Hon. J. T. C. Moore-Brabazon, P.C., M.P.
Minister of Aircraft Production

GLIDING flight, so patent to all watchers of Nature, seems to have been neglected through all the ages. There was little reason why efficient gliders could not have been constructed with the materials at the hand of many preceding generations, and had this been pursued with vigour the high-efficiency glider might well have come into use and the motive power required deduced therefrom to get sustained flight. The early pioneers of gliding flight never reached a glide of one in ten, but Lilienthal, Chanute and others were getting near that angle when the Wright brothers with their flexible biplane, controlled fore and aft aerodynamically instead of by transference of weight, showed a real advance in stability and the possibility of the introduction of an engine.

December 17, 1903, marks indeed a very great day in human progress and no credit is too high to pay the two Wright brothers for the tremendous concentration that they must have devoted to the construction of this machine, for not only did they construct the actual machine but also in fact, built an engine—no mean feat—which after gearing down by chains to two large-sized propellers, gave the necessary propulsive power to sustain flight. It is interesting to note that in the Wrights' patent their claim was for lateral stability. By gliding experiments they had found that putting extra warping on the depressed wing did not restore the aeroplane or glider to horizontal unless it was accompanied by rudder to force it to maintain its speed. The control for this was complicated, the rudder and side control being put on one lever, which was soon, however, found inconvenient. What is remarkable is the hiatus between the original experiments at Kitty Hawk and the demonstration of sustained flight which the Wright brothers gave in the United States and in Europe as late as 1908—five years. This latter machine, judged by the original which is now in the Science Museum, had become more robust, the under-carriage stronger and the engine more powerful, but generally the same scheme was adopted with the tiresome launching by virtue of reposing the machine upon—so to speak—a type of sleeper on roller skates which ran down a single rail pointed in the direction from which the wind was coming. Acceleration down this rail was accentuated by a weight hoisted in a pylon falling, it being attached round the end of the rail through a pulley and back to the machine. Acceleration to about 45 m.p.h. was obtained in 90 ft. by virtue of the kinetic energy of the weight and push of the propellers.

Analogous experiments had been proceeding in Europe. Santos Dumont had obtained a flight of about 100 metres with a vast dihedral biplane with no lateral control, of a very big box type with control in pitch for'ard. This flight took place in 1906. The propelling power was a very remarkable engine built by Levavasseur, a genius in design. The propeller was coupled to the engine shaft, but the engine was very remarkable for those days. It was an eight-cylinder V type. It had copper-deposited water jackets and fuel injection—an engine in fact twenty years ahead of its time. It was with this engine, however, that Farman in Paris with a biplane built by Voisin, again with no side control but with a stabilizing tail and single horizontal rudder in front, won the Archdeacon prize for a sustained flight of a kilometre in 1908. I flew several of this type; they were unstable in pitch and laterally uncontrolled.

The only outstanding aeroplane in those days from an aerodynamic point of view was the Antoinette, which was flown by Latham. Here again Levavasseur designed not only the engine but also the aeroplane, introducing steam cooling, a thing we have not yet reached in modern practice. This machine in its day was, I think, the most graceful, being a centrally winged monoplane, and it was a pity that it did not go down in history as the first machine to cross the Channel, as twice Latham failed by a matter of a few hundred yards.

There was a general attack upon flight in Europe by a succession of more and more powerful engines on singularly inefficient aircraft; exception might perhaps be made to the Bleriot, a light type of monoplane with warping wings, open fuselage and tractor screw. This historical craft that crossed the Channel was driven by an Anzani three-cylinder engine, but never again did this engine or one of similar type run for such a long period as when crossing the Channel, the reason being that it was kept cool and avoided overheating by virtue of a rain-storm which cooled it!

The next important contribution along the lines of excessive power rather than aerodynamic efficiency was the introduction of the radial engine of a rotating type, not the non-rotating radial as we see to-day. This was the famous Gnome engine. It had seven cylinders, exhaust valve on the top, and gave roughly about 40 h.p.

at 1,100 revs. per min. At first the amount of lubricating oil that was wasted by escaping centrifugally through the exhaust valve made the consumption of lubricating oil almost equal to that of the petrol. Somebody cleverly suggested the use of castor oil, which has the peculiarity of getting stickier the hotter it gets, and from that moment there existed an engine which was certainly comparatively reliable and successful.

Many remarkable flights were made with this engine, including the first London to Manchester by Paulhan and the glorious failure by Graham-White in the same competition. This was a great engine which contributed very much towards flight in Europe. Speeds, of course, had increased by now—and I am referring to 1910–11—from about 45 m.p.h. to 60 and 70 m.p.h. and the general trend was towards the monoplane type of construction in order to avoid parasitic drag. Seaplanes had come in by now and the Schneider Cup —the blue ribbon of seaplane racing—was won by that type of machine. The monoplane fetish was, however, completely upset by Tommy Sopwith's attack on the Schneider Cup, when he appeared with a biplane (1914) and had at least thirty-five miles up his sleeve. Again we were back to biplanes.

No great advance from the point of view of use—apart from exhibition—had been made until the outbreak of the War of 1914–18 when there was a tremendous concentration, regardless of economy or anything else except the war outlook, on aircraft in general. Some very remarkable machines and engines were constructed under pressure during that War. Machines jumped in horse-power from 50 to nearly 500, and they were exceeding 120 m.p.h. towards the end with regularity. The outstanding machines of the War were the Bristol Fighter, a biplane fighter—reconnaissance machine as we would call it now, two-seater, with engine, a Rolls, rather high up between the two planes; the Handley Page big bomber; and among fighters, the S.E.5, Sopwith Pup and the Camel. It is interesting to note that the 'pusher' type of machine was still favoured by some. The general trend of engine design on the British side at any rate was the multi-cylindered type, whilst the Germans concentrated on big six-cylinder units in line. The mushroom growth of aviation forced upon the world by war caused a very great reaction afterwards. Great Britain threw away her predominance in the air, and there was not very much imagination shown towards the possibility of joining the Empire closer together in time by virtue of flight.

Holt Thomas certainly had vision but no machines. He endeavoured to run a service to Paris and elsewhere on the Continent with old war machines, but the enterprise failed. But the idea that civil aviation had a future was born never to be killed. Generally it was realized, however, that civil aviation could not, in the words of the present Prime Minister speaking at that time "fly by itself", and subsidies throughout the world were started in order to foster civil aviation. But most nations spoke with their tongue in their cheek because fostering civil aviation meant, in fact, fostering an aviation industry built to make war machines. In fact some countries deliberately used war machines for civil purposes in order to find a use for them. Germany developed a very intensive internal non-economical commercial service in that they were not allowed war machines, but they were potential war machines. Great Britain started building two-engined heavy machines, but of vast surface with light wing loading—notably the Heracles built by Handley Page, slow, but a reliable money-making attempt at civil aviation.

However much various governments strove to get advanced with the ideal bomber, the real advance in aviation and especially in civil aviation came from the intense local competition which was being waged in the United States—a country ideally situated for long-distance air transport—among the various companies operating there in conjunction with manufacturing units.

Just as the Mercedes car suddenly emerged upon the motoring world five years ahead of anything else, so in aviation the Douglas machine marks an epoch in development. Here for the first time we had a machine completely clear of extraneous speed-reducing impediments. It was a skin-stressed machine, twin engine, tractor, of beautiful lines and of great comfort, and had three outstanding aerodynamic advantages: first of all the variable pitch propeller, which enabled it to get off with little run by virtue of low gearing the propellers and after attaining height increasing the pitch. It had a retractable under-carriage which in the realms of 200 m.p.h. meant a very great saving in drag and increased the speed for power. It had flaps which enabled the machine when they were depressed to take up a very coarse gliding angle, and allowed a machine so beautifully faired to come to rest in quite a small field, without running on. This machine was built ostensibly to serve the world, but is to-day the prototype for every long-range bomber. It is indeed a tragedy that a machine designed entirely for civil purposes should turn out in fact to be the ideal long-range bomber.

The radial engine and the liquid-cooled still continued to fight their battle for supremacy. The horse-power now is in the range of 2,000 and weights round about a pound per horse-power. Liquid coolers have the advantage of small frontal area; radials are simpler by virtue of air cooling. Height has now become a necessary part of engine

design, and here we find that it is not a function of power alone but of maintaining power at height by boost. Various boosts have been introduced on engines varying between the two-stage, two-speed blower, to the exhaust-driven turbine type.

I suggest that the future economical cruising stratum will be in the neighbourhood of 35,000 ft. If that is to be the right level then passengers cannot be asked to put up with the barometer at less than 6 in., so that pressurized cabins suitably heated and pressed will become the standard order of the commercial machine.

Long-range bombers have drifted into the four-engined type of great reliability with speeds up to 300 m.p.h., but they are voracious petrol eaters. Single-seater fighters with engines of 2,000 horse-power with wings not too heavily loaded, so that manœuvrability is not impaired, exceed the 400 m.p.h. mark. That is where we are to-day.

How all this is to be exploited for the benefit of inter-communication afterwards is difficult at present to say, and it is not clear how loads can in fact yet pay. We have perhaps come to the definite end of a type again, and it is not certain whether the tractor will eventually survive against the pusher, or whether present power units, with their big disk area propellers, are the end of the story. Aeronautics is now a science and development will not stop. There are great possibilities looming ahead, revolutionary in character ; but the present situation may be prolonged by a great increase in wing loading with assisted take off.

Here is a brief résumé of the results of those first experiments by the Wrights. (Mr. Orville Wright celebrated his seventieth birthday on August 19. See NATURE of August 16, p. 191.) It is indeed the duty of man to see that what the Wrights first introduced—one of the greatest inventions and contributions to mechanical science—is eventually used for the benefit of the world and not for the destruction of civilization. We cannot blame the Wright brothers for the prostitution of their invention that has taken place. Those of us who knew the two brothers will always cherish affection for them and the memory of two remarkably quiet, charming people. It will be for succeeding generations to prove that they introduced into the world, not a curse, but a means of transport which will eventually bind nations together on a basis of mutual understanding and goodwill.

CROP DAMAGE BY AIR ATTACK

By SIR JOHN RUSSELL, F.R.S.
ROTHAMSTED EXPERIMENTAL STATION

TWO possibilities of damage to crops by enemy action are now so near that warnings have been issued along with instructions showing what is to be done should the necessity for action arise. The Ministries of Home Security and of Agriculture have sent out to farmers three leaflets giving simple but precise methods for coping with attempts to destroy our crops either by fire or by poison gas.

In regard to fire, the problem is an old one in Australia and in Canada, so that a certain amount of experience is already available. In both countries the prairie or bush regions are liable to become very dry during periods of drought, and a spark or even a cigarette end may start a conflagration that races over miles of country, causing havoc wherever it goes. I shall never forget the Australian bush fires in the summer of 1938–39 (December and January) ; they were impressive beyond words, and one marvelled at the skill and courage of the Australians in facing up to what seemed irresistible devastation, gradually limiting and finally subduing it. In Great Britain experience is far more limited, and except for occasional fires started by picnickers or campers in young forestry plantations, the only fires ever seen in British fields are those caused by sparks from railway engines. But, small as it is, this experience is invaluable at the present time, and has clearly been drawn upon in the preparation of these pamphlets.

The reason so few field or forest fires are seen in Great Britain is, of course, the unsuitability of the climate. Occasionally, it is true, we get a summer where crops and grass dry up and look as if they would burn easily. 1940 was an example, and it is fortunate for us that the Germans made no large-scale attacks then. 1941 has been much wetter, and nothing could have fired the crops this summer. In spite of this, however, the Ministries are taking no risks, and are issuing instructions should the case arise.

Greenleaf crops are obviously exempt from risk, and the only danger might come to cereals. Oats are usually cut before they are dead ripe, and they normally still contain so much sap as to be non-combustible ; no danger arises from railway-engine sparks, and it may be assumed that incendiary

leaves or bombs would be harmless. Wheat is left longer and dries out more: it does not usually, however, become dry enough to burn easily, and railway-engine sparks rarely set a wheat field on fire. Barley, however, is generally left until it is dead ripe, and becomes drier than any other of the cereals, hence it is most likely to catch fire. Even so, barley fires are not very common, considering the number of barley fields in the country, and the total loss of standing corn is not great. As barley fields are scattered in among oat, root and grass fields, the danger of spreading, even if a fire should start, is only small.

The most serious risk is on the stubbles, if very dry weather should set in after the harvest. The short residual straw easily dries sufficiently to become inflammable, and if a fire starts it creeps over the field. There is no harm in that, so long as the fire keeps to the stubble; even some good may result if the heat is sufficient to kill insects and their eggs, and to destroy fungi and weed seeds; also the heating of the soil liberates plant food. But if sheaves of corn are still standing out, or if a stack of corn or of hay has been built up in the field, then there is danger that it may be set on fire.

Fortunately, Australian and Canadian experience shows how to give protection: the stubble should be ploughed up as speedily as possible, or if that be impracticable, then strips must be ploughed so as to divide the field into compartments; if a fire starts in one of them it can go no farther. Stacks must be well isolated from each other and from the stubble; they are best put in grass or root fields, but if they must be in a cereal field they should be surrounded by a belt of ploughed land.

Hedges also are liable to catch fire, especially if they contain much dry material at the bottom, as not infrequently happens. The precaution here is to keep the hedge well cut back and well cleaned.

In view of the fact that most of our grain is grown in the dry parts of England, the amount of water available for putting out a fire may not be great. Methods are indicated in the leaflets for organizing water supplies, and making such arrangements as are possible beforehand for facilitating action when the fire comes. Beating is effective, and although many parts of the country-side are familiar enough with the simple form of this operation that suffices for dealing with gorse and heather fires, a serious field fire would need more elaborate precautions, and these are duly described.

This fire danger has attracted the attention of a number of the farmers' organizations. The Hampshire Branch of the National Farmers' Union has issued recommendations which include such important details as the cutting and ploughing up of fire breaks through standing crops across the direction of the prevailing wind, but emphasizes the need for organizing groups of fire watchers and helpers, since the first minutes are always the most important.

The danger from gas is more oppressive because it lies right outside the countryman's experience, and every untested danger seems terrifying until it has actually come. It might not come at all, and if it does, it might prove relatively harmless. Certainly, the bombs that caused so much fear in the country-side before they arrived were treated with scant respect once it was seen how little damage they do in a field: a hole that is quickly filled in, or a fence that is soon mended, and all signs are removed. Many farm-workers have spoken contemptuously of the bombs: "They didn't even kill a rabbit" was a common phrase, and there was great relief at finding that the much-vaunted terror had so little substance. There is, of course, a world of difference between an open field and a crowded city.

It is possible that gas bombs in the fields would be equally innocuous, but the Ministry has set out instructions as to what should be done if they come. As the instructions cannot cover every possible case, the first and chief one is to get in touch promptly with the gas identification officer of the local authority.

Only persistent gases are considered likely to do serious harm, and of these the blister gases are the most important, especially mustard gas; but it is stated that still further caution would be needed against lewisite, on account of the risk of arsenic poisoning. Two modes of distribution are dealt with: by bombs and by spraying; bombs cause intensive contamination over a small area, and spraying a less intense contamination over a larger area. The crops become discoloured or scorched in appearance, and some of the liquid may remain either on the plant or on the soil; mustard gas has a faint, rather onion-like smell, while lewisite sometimes, but not always, has a smell of geraniums. The instructions to the farmer are quite simple: he must keep human beings and animals out of the affected areas, and get in touch with the local A.R.P. authorities, who will presumably have access to experts able to give fuller advice. Visibly damaged crops should not be fed to animals, though if grain crops survive and continue to grow, the expert might advise that they could be used as seed.

Stored crops usually present less difficulty. The usual protective agents, clamps, thatch, barns, and tarpaulins are said to be adequate against blister gas, and nothing more than prolonged airing is needed to overcome the trouble. Concrete silos

give complete protection, so long as the top is closed, but wire and paper silos may not always prove adequate, and a certain amount of dismantling and cutting out may have to be done. Stack or clamp silos afford no protection, and any part that has been splashed or sprayed must be removed and destroyed. Running water is safe, and need cause no anxiety, but water in shallow ponds or storage tanks, if contaminated with blister gas, may remain dangerous for long periods.

Naturally, one hopes that these particular dangers may never arise, but it is comforting to realize that if they should the Ministries of Agriculture and Home Security are alive to the possibilities, and that farmers have been forewarned and advised as to what steps they should take.

DRUG PLANTS NATIVE TO GREAT BRITAIN

By Dr. W. O. James

Botany Department, University of Oxford

APART from herbalist simples, there are some half-dozen or so plants of Europe and the British Isles which yield drugs of first-class medical importance. The annual consumption of Great Britain runs into hundreds of tons of crude dried material, almost the whole of which normally comes from the Continent, particularly from Belgium, Germany, the U.S.S.R. and the Balkans. Consumption is not limited to the requirements of the people of Great Britain. A re-export trade of refined drugs exists on a considerable scale and, since this largely goes to the western hemisphere, and is economical in its demands on cargo space, there is point in trying to keep it alive at the present time.

First, however, must come home needs. The Ministry of Health has issued several pronouncements stressing the importance and urgency of the question of supply and, through its Vegetable Drugs Committee, has reviewed the situation and made certain cautious recommendations.

Serious shortage already exists of some of the drugs in question, a situation which had its parallel in the War of 1914–18. The steps taken then were only partially successful, but should afford some useful background of experience now, though it is too early yet to say whether the implied lessons have been learnt.

The steps open to us include collection of wild plants and increased cultivation. Each is very narrowly restricted both by botanical and economic causes and will require skilful and determined handling if anything useful is to be achieved. The Ministry of Health has ruled that war-time production must remain on a commercial basis. Strictly speaking, this is impossible. It is true that the produce is being handled through the usual trade channels, but collection depends upon volunteers who can receive nothing commensurate with any normal valuation of their time and labour. This end of the effort is essentially a gift to the country—a commendable if indirect war-service—and should be recognized as such. It is being undertaken by women's institutes, women's voluntary services, boy scouts, girl guides and some schools.

Government assistance has not been lacking. The Ministry of Health has sought to give a lead, and has provided machinery for co-ordination and advice. In hard cash, grants have been given to certain famous and well-established firms to enable them to extend their drying-plant and, on a smaller scale, to the Oxford Medicinal Plants Scheme, which has been called into existence to make selections from the native wild plants, combining trials with a limited scale of present production.

It has been officially recommended by the Ministry of Health and the Medical Research Council that effort be concentrated on *belladonna*, colchicum, *foxglove*, male fern, *henbane*, sphagnum, *stramonium*, dandelion-root and valerian, with special emphasis on the four italicized. This recommendation does not seem to have received all the attention it deserves. Besides these plants of well-established therapeutic value, the flora of Great Britain contains many more which are normal articles of the drug trade, but the value of which no responsible medical man would put in the same category. Bluntly speaking, nobody is going to die prematurely or suffer great pain for lack of them, as many might suffer or die for lack of belladonna or foxglove. By no effort of the will can the harvesting of such inessentials be made to appear a significant contribution to the war effort. Nevertheless, judging from the inquiries and literature I have received, there seems to be a real danger of anxious and willing help

being dissipated upon them. Nor does it appear an adequate argument that there are districts where none of the important drug plants are to be found. In such places, which are, of course, numerous, effort would be better directed to something else; the much-besought women's institute member might better be left at her preserving-centre and her husband on his allotment.

Cultivation is limited to the 'big four', with some valerian. It has its own special difficulties and seed is not easy to come by. Moreover, the market could very easily become over-supplied if cultivation were begun by numerous growers on a large scale. It is clearly undesirable to stimulate a demand for such plants artificially, and for these reasons growing by amateurs and farmers, other than the already established specialists, has not been encouraged. The latter, however, have somewhat expanded their normal acreage.

The appeal for public assistance is concerned with collection. Within my own experience landowners have usually proved helpful and co-operative. A few wish to sell, especially where belladonna is concerned, and there have been very rare refusals of help or permission to collect.

The real crux, however, lies in the question of drying. Fresh herb as collected cannot be transported over any considerable distance both on account of prohibitive cost and of damage by bruising the leaves. Ten or fifteen miles is an extreme range and the latter figure is probably beyond it. It follows that the really worth-while effort is to get drying-sheds established in the centre of a zone thickly populated by the plant required. This puts foxglove into a class by itself. Valerian root may be collected in some swampy districts; henbane is rare in quantities large enough for commercial gathering though I have received reports of "fields full" here and there. We are able to collect a small amount of belladonna in Oxfordshire and the adjacent counties, but other resources are slender. Colchicum and male fern are locally abundant and worthy of serious attention in the west. Stramonium is only an occasional escape and inhabitant of waste-tips. The collection of dandelion root is a formidable undertaking and its use for the relief of dyspepsia, valuable though it is, is not to be compared with the irreplaceable role of digitalis as a cardiac stimulant. Foxglove, moreover, exists in abundance over wide areas which are still largely untapped. Initial results obtained by the Oxford Medicinal Plants Scheme, with the co-operation of the Botany Department at Bangor, suggest that the foxglove on the Welsh hills has an unusually high digitalis potency. An exceptional effort towards its gathering would seem to be indicated.

Everyone is agreed that drying-plant must be of a makeshift kind. There is no guarantee of a certain market for these products after the War; in fact they are more than likely to be displaced again by cheap imports from the Continent. Capital sunk in permanent drying-sheds would be sunk indeed. The temporary use of hop-kilns has been suggested; but very considerable additions of shelf-area are needed since drug plants are wetter and need much thinner spreading than hops. Consultation with a firm near Oxford made it clear that the attempt was likely to involve serious financial loss. Forced-air systems with their relatively high running costs appear to be out of the question. Occasionally, institutions are willing to allow the use of large airing-rooms with central heating. Since there is then no further outlay for fuel or shelving, this plan works to admiration. The only method of general application is that of the handyman who can knock up shelves of wood and netting in some available outhouse. When allowance is made for putting in the essential stove, the most modest attempt involves an expenditure of ten or fifteen pounds. Ten pounds is the market value of about 2 cwt. of dried foxglove leaf, or getting on for a ton of leaf as gathered—far more than such a shed could handle in a single season, and this is making no allowance for coke and other costs of operation. There is also implied a great deal of active gathering by a considerable number of women or supervised children in the field and a great deal of uncomfortably hot and tiring work spreading and turning the leaf in the driers.

Each drying-centre, small though it may be, needs the constant supervision of a man or woman of untiring and persuasive nature to keep it actively in operation. A modicum of expert knowledge is also needed, and there is much greater scope and need for the help of botanists on the spot than has yet been realized. Botanists are often exercised at the present time as to how they can turn their special training to the public good. Those of a practical turn could find something valuable and patriotically useful to do in building up and running such drying-centres. It need not be at all a routine job. Very little seems to be known about the best methods of drying, a purely empirical judgment of colour being a common basis of values. There is need for the collection of numerous data both for direct technical and more academic purposes. This amounts to a good deal more than spare-time work and can probably only be achieved as a recognized activity for a botany department. In my view, the help of many more such institutions and their personnel is essential if this war-time emergency work is to be carried out with full success.

PHYTIC ACID AND THE PREPARATION OF FOOD

By E. M. WIDDOWSON,
DEPARTMENT OF MEDICINE, UNIVERSITY OF CAMBRIDGE

NOW that something definite is known about phytic acid metabolism and about the extent to which this compound interferes with the absorption of calcium, the quantities in our daily food have become almost as important a nutritional counter as the amounts of calcium. In fact, following Harrison and Mellanby's work on dogs[1], and the experiments on men and women which have been carried out in this Department[2], it has become clear that the phytic acid/calcium ratio determines whether a diet will promote the absorption of calcium or facilitate the production of rickets. Foods have been analysed for calcium and for phytic acid, but there is another aspect of the matter which has not yet received the attention it deserves. It is known that the rat possesses a digestive enzyme which will hydrolyse phytic acid[3]. It is thought that other animals have not; and consequently it is generally assumed in human nutrition that the phytic acid in wheat and other natural foodstuffs can be broken down only by the bacteria in the intestine. There is, however, a phytase in wheat, and the purpose of this note is to show that this enzyme is active in commercial flours, and that it may destroy phytic acid during the accepted cooking processes.

Phytic acid in wheat is located chiefly in the bran, and consequently the more bran included with the flour, the greater the amount of phytic acid in it. Representative figures may be taken to be follows:

		Phytic acid mgm./100 gm.
White flour	70% extraction . .	51
National Wheatmeal	85% extraction . .	127
Wheatmeal	92% extraction . .	214

The table opposite shows the destruction of phytic acid which has been found to follow the conversion of these raw materials into food. It will be seen that baking with yeast led to considerable hydrolysis, and the more refined the flour, the greater the percentage destruction. In fact, the phytic acid in white flour was very largely removed by this process. 'National' bread also contained much less than the flour from which it was made. 92 per cent flour not only contained most phytic acid, but also the percentage destruction on baking was the least.

There was very much less destruction when baking powder replaced the yeast, and there were probably two reasons for this. First, when the yeast dough was set to rise, it afforded the enzyme an opportunity to act upon its substrate before it was itself inactivated by the rise of temperature in the oven. In baking with sodium bicarbonate and cream of tartar the doughs were put into a hot oven as soon as they were mixed and the temperature was rapidly raised to a point at which the enzyme was destroyed. Secondly, the optimum pH of wheat phytase is in the region of 5·5[4]. The enzyme is never given a chance to act at this reaction in the usual cooking processes, but the hydrogen ion concentration of a yeast dough is much more favourable to the activity of the phytase than that of a baking powder dough. As might have been expected from the results with bread, there was some destruction of phytic acid during the preparation of a steamed pudding. This was cooked in the usual way in a pudding basin, and was of a size suitable for five or six persons, so that the temperature of its centre probably rose quite slowly. There was no destruction of phytic acid in the baking of wholemeal pastry. This was made with a dry dough and heated very rapidly.

DESTRUCTION OF PHYTIC ACID ON COOKING

Nature of flour	*Cooked product*	*% destruction of phytic acid*
White (70%)	Yeast bread . .	85
National Wheatmeal (85%)	. . . . .	69
Wheatmeal (92%)	. . . . .	31
,, ,,	Baking-powder bread.	5
,, ,,	Steamed pudding .	16
,, ,,	Pastry	0
White (70%) with added sodium phytate	Baking-powder bread	15
,, ,,	Steamed pudding .	60
,, ,,	Pastry . . .	15

The table also shows the destruction of organic phosphorus which took place when enough sodium phytate was added to white flour to make its concentration equal to that in 92 per cent flour. More phytic acid was destroyed in baking and cooking with this product than with 92 per cent flour. This may have been because sodium phytate is more soluble than the phytates naturally occurring in the wheat, but in any event there was evidently an active phytase in the 70 per cent flour. Hence, either the enzyme is naturally more dispersed than its substrate through the endosperm, or it becomes separated from its substrate by the milling processes.

The cheapest and most effective way of frustrating the noxious action of phytic acid is unquestionably to add calcium to flour, but something can evidently be done by cooking in a suitable manner. It is hoped that these observations—in the present emergency or later—may find some application to the service of man.

Miss B. Alington prepared most of these foods. The expenses were covered by a grant from the Medical Research Council, and the author is in the whole-time service of the Council.

[1] Harrison and Mellanby, *Biochem. J.*, 33, 1660 (1939).
[2] McCance and Widdowson, Spec. Rep. Ser. Med. Res. Coun. (1941). In the press.
[3] Patwardhan, *Biochem. J.*, 31, 560 (1937).
[4] Kolobkowa, *Biochimia*, 1, 512 (1936).

A CLASSIFICATION OF THE EOLITHIC INDUSTRIES OF ENGLAND

By J. Reid Moir, F.R.S.

In view of the considerable number of discoveries made in England of eolithic implements of various kinds, it seems desirable to attempt a classification of these artefacts, as a first step towards that which has been made of the later palæolithic industries. There is no doubt that the original classification of these implements was of great value as enabling us to visualize the main stages of palæolithic man's existence, and the great length of time absorbed during the ebb and flow of his material advancement. Though the late Prof. Rutot of Brussels published, many years ago, a classification of the eolithic industries found in Belgium and France, no attempt has, hitherto, been made to classify the English eoliths—the study of which remains in the unsatisfactory state of the palæolithic artefacts in pre-classification days.

It is necessary, however, to point out that the classification of the English eoliths must differ in an important manner from that which has been formulated for the palæolithic industries. In the case of the latter many actual 'floors', or sites of occupation, have been found resting upon, and covered by well-known deposits of which the geological age has been ascertained. Though very ancient, the palæolithic races lived near enough to our own time to make it possible for some of the beds in which certain of the land surfaces on which they lived, were embedded, to survive the intense, destructive geological agencies which have operated since these beds were accumulated. Thus it has been found possible to fix, with considerable accuracy, the geological age of certain palæolithic 'floors' in England. But, in the case of the eoliths, the passage of time since they were made has been so extended that the deposits in which they were originally embedded have, in England, long since been destroyed, and the eolithic artefacts are now found only in beds composed of the wreckage of these older deposits.

The Suffolk Bone Bed, beneath the Red Crag, is a typical example of such a *remanié* accumulation, and contains, in addition to the bones and teeth of land mammals of late Miocene and Pliocene age, together with certain pieces of fossil bone artificially shaped, no less than five groups of flint implements which, by their differing patinations, and re-worked examples, can be recognized as of different ages[1]. As these remote relics of man are found, almost exclusively, as derivatives in the Suffolk Bone Bed, of Upper Pliocene age, it follows that their makers must have lived in some at present unspecified period, or periods, prior to that in which this bed was accumulated. There would appear to be six eolithic stages represented in England—though more may eventually come to light—and these are as follows :

(1) *Kentian.*—The Kentian specimens were first found by Benjamin Harrison in and upon the high plateau gravel of Kent. They are made, chiefly, from naturally produced pieces of flint of tabular form, which have been modified by steep flaking along their edges, causing them to assume the shapes of points, borers and scrapers of more than one type. For many years after their discovery the age of the Kentian eoliths, though regarded as, in all probability, very great, remained unknown, but it is now apparent that another series of eoliths, the Cantalian, found at Aurillac, Cantal, in central France, resembles the Kentian artefacts so closely that it is reasonable to suppose they are of the same age[2]. The geological deposit, a gravel, in which the Cantalian eoliths occur, is fortunately known, and referable to the Upper Miocene period. The following five groups of eoliths were found in the Suffolk Bone Bed beneath the Red Crag.

(2) *Bramfordian.* The Bramfordian specimens were discovered, most frequently, in Coe's pits, Bramford, near Ipswich. The colour of the majority of the flints is a peculiar archaic-looking, washed out yellow, while they exhibit signs of

much rolling by water action and heavy striation. The Kentian tradition is very clearly marked in these specimens, which, however, show an advance in technique as they are often made from primitive flake implements exhibiting steep edge-flaking. Rostro-carinates are present in this group.

(3) *Boltonian.* The Boltonian specimens occurred most freely in Bolton and Co.'s brick-field, Ipswich. The prevailing colour of the flints is a rich chestnut brown carrying a well-marked gloss, and they show considerably less signs of rolling and striation than the Bramfordian series. The implemental types are also much more varied and advanced than those of the latter specimens, and comprise rostro-carinates, points, racloirs, scrapers, cores, etc.

(4) *Whittonian.* The Whittonian specimens are a small group, found chiefly in Coe's pits, Bramford, and Bolton and Co.'s brick-field, Whitton, Ipswich. The colour of the majority of the flints is an unusual speckled yellow, and they exhibit very slight signs of rolling and striation. A few rostro-carinates are present in this group, but the greater proportion of the artefacts are racloirs, with one or two scrapers.

(5) *Thoringtonian.* The Thoringtonian specimens equal, approximately, the Boltonian in number, and are found chiefly in the pit at Thorington Hall, Wherstead, near Ipswich, and in the cliffs at Bawdsey, Suffolk. The prevailing colour of the flints is a dense white, or cream, while some of the specimens are patinated blue. The majority of the flints are only slightly rolled and striated, while some are unabraded. Rostro-carinates are rare, while the greater number of the artefacts, which exhibit considerable skill in their manufacture, comprise points, racloirs and scrapers.

(6) *Henleyan.* The Henleyan specimens are a very small group of unpatinated, unabraded, and non-striated artefacts, found chiefly in Bolton and Co.'s brick-field, Ipswich. The predominant type is a skilfully made racloir, and from the condition of these specimens it is legitimate to infer that they were actually made at the site of discovery. No rostro-carinates are present. The titles I have given to these various eolithic industries are based upon the names of the actual pits where the specimens were found, or upon those of the immediate neighbourhood of the excavations, and it is to be hoped that they will pass into general use as have those given to the palæolithic cultures—Chellean, Acheulean, Mousterian, and so on. An examination of the groups of English eoliths must impress unbiased and competent observers as representing a slow but definite evolution of flint implements, and as forming the probable and necessary background to the earliest palæolithic cultures. It has been shown[3] that the eolithic points of the Kentian industry developed into the rostro-carinates, and these into the earliest palæolithic hand axes, and it may well be that the Stone Bed beneath the Norwich Crag in which the latter are found is the geological successor in Norfolk to the Suffolk Bone Bed in which the eoliths occur. The chronological succession of the industries from beneath the Red Crag is irrefutably established by the evidence afforded by the re-flaked specimens, while the difference in technique employed in the various pre-Crag periods seems manifest. I do not think it desirable to place the artefacts found at two superposed occupation-levels in the Red Crag at Foxhall, Suffolk, in the eolithic period. The Crag itself, as distinct from the Suffolk Bone Bed beneath it, is, I think, best regarded as of Early Pleistocene age, and it is possible that the Foxhall specimens are of the same period as those of Group 5 from the base of the Cromer Forest Bed[4] and referable, therefore, to the beginning of lower palæolithic times.

[1] *J. Roy. Anthr. Inst.*, 65 (1935).
[2] I hope to publish a special monograph on the Cantalian industry in the near future.
[3] "The Antiquity of Man in East Anglia" (Camb. Univ. Press).
[4] NATURE, 147, 530 (1941).

OBITUARIES

Prof. E. Barnes

PROF. EDWARD BARNES, professor of chemistry at the Madras Christian College, died suddenly at the end of May 1941 at the early age of forty-nine. During the past twenty years Barnes had developed a passion for botany and utilized every opportunity for the pursuit of his hobby. He spent most of his holidays making extensive tours in the hills of South India, and even during a stay of a few days in Ceylon, when returning from leave in England, he managed to find a new species of Arisæma. Assisted by his wife, he made a close study of the vegetation in the vicinity of his camps, and this assiduous research led to the discovery of a number of new species of herbaceous plants, all of which were described in either the *Kew Bulletin* or the "Icones Plantarum".

While collecting the majority of the species he encountered, he devoted particular attention to the genera Arisæma (Araceæ), Impatiens (Balsaminaceæ)

and Sonerila (Melastomaceæ). Especially in connexion with the first-named he recorded many observations of interest, including some with reference to their relation to the insects that effect their cross fertilization. Some of his conclusions were published in the *Journal of the Natural History Society of Bombay*.

His herbarium specimens (a considerable number of which, including all the type-specimens, were presented to and are lodged in the Kew Herbarium) are particularly well selected and preserved; many retain their natural colours and some are so prepared that all the floral parts can be seen without further dissection.

Barnes's friends, besides feeling the loss of a good companion, are convinced that botanical science has been robbed of one who would have brought much further knowledge of plant life to light.

C. E. C. FISCHER.

WE regret to announce the following deaths:

Dr. John Ball, technical counsellor to the Survey of Egypt.

Mr. Claude Hutchinson, C.I.E., formerly Imperial bacteriologist, Pusa, lately chief scientific adviser in India to Imperial Chemical Industries, Ltd., on August 2, aged seventy-two.

Mr. C. Pendlebury, senior mathematical master at St. Paul's School during 1877–1910, honorary secretary of the Mathematical Association during 1886–1936, on August 18, aged eighty-seven.

NEWS AND VIEWS

Comenius Tercentenary Commemoration

JAN AMOS KOMENSKY (COMENIUS), the great Czech educational pioneer, author of the "Janua Linguarum", "Didactica Magna", and many other books, paid a visit to England in 1641. His resolute internationalism and his plan of a "Pansophic College" for co-operative scientific research were among the influences leading to the formation of the Royal Society, which, in its first form, the Invisible College, began its meetings in 1649. Unfortunately, the Civil War, and his failure to find in any other country a patron able and willing to carry out his schemes, postponed the realization of his ideas, which he never lived to see.

On October 24, a meeting will be held in the Senate House of the University of Cambridge at which the following discourses will be delivered: President Benes, "Comenius's Plans for Peace Leagues and his Place in History as a Great European"; Mr. Jan Masaryk (Foreign Minister of Czechoslovakia), "Comenius as an Educational Pioneer"; Prof. J. D. Bernal, "Comenius's Visit to England and the Foundation of the Royal Society"; Prof. Ernest Barker, "The Debt of Europe to Comenius and to Czechoslovakia". These, together with contributions from other distinguished scholars, will afterwards appear in the form of a small commemoration volume. Official representatives will, it is expected, be present on behalf of the embassies and Governments o Czechoslovakia, the U.S.S.R., Poland and Yugoslavia, the Board of Education, the Royal Society, the British Council, the Moravian Church (of which Comenius was a bishop), etc. The Tercentenary Committee consists of the Vice-Chancellor of the University of Cambridge, Mr. H. Butterfield, Prof. G. Haloun, Sir William Dampier, Prof. G. R. Owst, Mr. B. W. Downs and Dr. J. Needham, to the last-named of whom, at Caius College, any communications regarding the tercentenary should be addressed.

Photo-Electric Devices for Detecting Incendiary Bombs

THE British Standard Specification (A.R.P. Series) for the performance of photo-electric devices for the detection of incendiary bombs forms one of a series of standards prepared by the British Standards Institution at the request of the Ministry of Home Security (*BS/ARP* 60. British Standards Institution, 28 Victoria Street, London, S.W.1, 6*d*., post paid 8*d*). The alarm is normally intended to be given within or near the premises so equipped for the purpose of warning fire-watcher parties, and is not primarily designed to call the public fire-fighting services or to bring automatic fire-extinguishing equipment into action. The photo-electric devices may be of various types incorporating light-sensitive cells, including (*a*) photo-conductive cells, (*b*) photo-emissive cells, and (*c*) photo-voltaic cells. The alarm device must be battery operated and give an audible signal which may, if desired, be supplemented by a visual signal. The power supply to the alarm circuit must be obtained from a battery the nominal voltage of which shall not be less than 3, and this battery must be used exclusively for the alarm circuit. The methods of carrying out type tests, routine tests and the test after installation are described.

An appendix deals with the photo-electric cells commonly in use, namely, the selenium cell, the alkali cell and the rectifier cell. The term 'photo-electric cell' is sometimes used as a generic term to embrace these three main types of cell, together with all other devices capable of producing changes in an electric circuit by the action of light. It is preferable, however, to distinguish more clearly between the three main types. The selenium cell is the most common example of a class of semi-conductor the ohmic resistance of which is a function of the illumination to which the cell is exposed. Such cells are termed 'photo-conductive cells'. In the alkali cell there is an electron emission across a vacuum or gas-filled space, and such cells are termed 'photo-emissive cells'. When the term 'photo-electric cell' is used in a restricted sense, it usually relates to the photo-emissive class of cell. The rectifier cell belongs to a class which is termed photo-voltaic. Such cells consist of a contact between a metal and a semi-conductor, and one of the most efficient semi-

conductors for use in rectifier cells is selenium. Such cells must not be confused with selenium cells in the photo-conductive class.

Myths of Sun Snaring

In a recent paper ("Oceanic, American Indian, and African Myths of Snaring the Sun", by Katharine Luomola, Bernice P. Bishop Museum, Bull. 168; 1940) the author has made an exhaustive study of myths and magical practices for sun snaring which she has collated and analysed. In each section the stories and processes are given in full and then compared with each other and with those of the other sections, and by this method possible centres of diffusion have been determined. There are striking similarities in some of the myths, for example, in the use of a woman's hair as a snare, which tale, with variations, seems to have diffused in Polynesia from the Society Islands, and in North America from the Lake Superior Ojibwa and the Menominee.

Other myths show less resemblance and could easily have arisen independently, and on the whole the author's conclusion is that the evidence is not sufficient to show a common origin for these two areas. Similarly with the African myths and magical processes; although there are parallels between the Nandi and the Melanesians in knotting grass to retard the sun, this alone can scarcely be sufficient evidence of contact. As regards cat's-cradles, the author is mistaken in her statement that these are forbidden by the Iglulik during the winter; according to Jenness, this is the season at which they are allowed. There are two distribution maps, numerous authorities are quoted and the paper forms a useful addition to the study of sun myths.

Canadian Aerial Forestry for Burma

In the *Indian Forest Records* (Silviculture (New Series), 4, No. 1; Govt. of India Press, New Delhi, 1940), Mr. J. D. Braithwaite of the Burma Forest Service discusses the great advance which has been made in discovering comparatively cheap methods of applying aerial survey to solve forestry problems, and considers that these methods should be applicable to Burma. Burma started before India in making use of the aeroplane in connexion with the forests, for during 1924–25 the Delta and the Heinze Basin were both surveyed from the air with good results. Mr. Braithwaite relates that immense strides have been made in Canada in air work in the last ten to twelve years—strides which were to a great extent unknown even to the United States alongside. Their chief importance is their practical nature and cheapness as compared with methods in force in England, or, to quote an example given by the author, Germany, where he remarks "the scientists have got hold of both the photographic and mapping operations to such an extent that a very expensive and highly trained staff is needed to work the very delicate and costly machinery that has been painstakingly developed".

Obviously this would be as useless as impossible for the great areas of the Empire forests. It is in this simplification and cheapening of methods to which Canadian investigators have directed themselves, and Mr. Braithwaite during a visit to Canada for the purpose was able to study the work with thoroughness, as his monograph well displays. Some of the forestry problems of chief importance in which aerial survey can give the greatest assistance are (1) the problem of mapping small plantations; (2) the thinning of young plantations and an examination of the degree of stocking; (3) stockmapping, and the distinguishing of individual species in a mixed forest, from the air.

Horticulture of the Amaryllidaceae

The title of the periodical *Herbertia*, though somewhat concealing to the uninitiated, covers a concentrated scientific approach to the horticulture of the Amaryllidaceæ. It appears as the yearbook of the American Amaryllis Society (from the Editor, Dr. H. P. Traub, Orlando, Florida, U.S.A.). Vol. 7 for 1940 announces the description of two new species, *Amaryllis aglaiæ* and *Zephyranthes Fosteri*; it discusses the phylogenetic position of several groups within the natural order, and acts as a genetic record for the origins of many hybrid introductions. The first part of a large-scale review of the breeding and testing of day-lilies (Hemerocallis) further indicates the sources of various characters which have been combined to form clones of proved horticultural excellence.

A paper by Dr. A. B. Stout correlates the vigour of shoot growth with the origin of a clone, and W. M. James outlines briefly the methods of growing Alstroemerias from seed. Germination is optimum when the seed has been subjected to a temperature of 77° F. for two months, followed by one month at 50° F. The same author has also a short paper on the best conditions for harvesting and storage of amaryllid bulbs. A method of preserving herbarium specimens in their natural colours by drying in sand is described by Dr. H. P. Traub. *Herbertia* ministers to the practical cultivation of its particular group of plants; it also maintains a welcome personal character, for the pioneers of Amaryllid culture are described in biography. The volume is withal an excellent example of what yearbooks should be.

Celluloid for Cycle Accessories

One of the most interesting features in the development of the British bicycle industry during the past sixty years has been the growth of a group of specialist manufacturers whose products have had a great deal to do with the success of the modern British lightweight bicycle in the markets of the world. The *Export Trader* of August says that by careful experiment, continuous research and insistence on high quality they have produced components, parts and accessories for bicycles in steel, rubber, celluloid and other materials which, because of their lightness combined with their strength and durability, have enabled British cycle manufacturers

to turn out machines better than those of any other country.

Among this group of specialist manufacturers is the firm of Bluemel Bros., Ltd., Woolston, near Coventry. At an early stage in the firm's history the brothers Bluemel realized the advantages of the application of celluloid with its inherent lightness and freedom from dust to bicycle design, and now a large number of the accessories which the firm manufactures are made of this material. The celluloid type tyre inflator was a great success from the start. It was able to withstand the rough and tumble of every-day usage without becoming dented and thus put out of service. Its smooth and easy action is also another commendable feature. Later the Company started to produce celluloid chain covers for cycles. Celluloid mudguards have also been very successful. Quickly detachable fittings of light construction enable the rider to attach or remove them without interfering with the wheels. Celluloid cycle handles are coated with strong adhesive and only require moistening before placing on the handlebars. The 'Cushion Grip' rubber handle is very comfortable to use, although, unlike sponge rubber, it does not absorb moisture.

Recent Earthquakes

TWENTY well-established earthquakes were registered at the Swiss observatories in March 1941, and nineteen in April 1941, according to the bulletins just received. Some of these were distant earthquakes mentioned previously in NATURE, but some were local. On March 12 an earthquake was felt with intensity 4 on the Rossi-Forel scale at Lokalstoss in Andermatt. On March 28 an earthquake with intensity 3–4 was felt in Canton Graubunden, its epicentre probably being south-east of the Ortlergruppe. On March 29 an earthquake with its epicentre near Oberwallis was felt in Visp with intensity 4. The only local shock in April was apparently on April 6 and had an epicentre near Val d'Anniviers and was felt in Vissoie with intensity 5.

THE Jesuit Seismological Association of St. Louis has recently determined the epicentres of two strong earthquakes. The first shock was on January 5, 1941, with tentative calculated epicentre 2·0° S., 123·7° E. and T_0 18h. 46m. 44s. G.M.T. The depth of focus was considered somewhat deeper than normal, and this is not surprising since earthquakes from this region are often from a deeper than normal focus. The epicentre is near the centre of the island of Celebes in the Dutch East Indies. The second was on February 9, 1941, and was felt at Eureka, California. The tentative epicentre was calculated to be at 41·1° N., 125·5° W. with T_0 9h. 44m. 5s. G.M.T. and depth of focus probably near normal. It probably had the same epicentre as the earthquake of January 31, 1922, which has been described by J. B. Macelwane, S.J. (*Bull. Seis. Soc. Amer.*, 13, 13; 1923). For both earthquakes complete readings of seismograms from several American observatories are given.

Theodor Kocher (1841–1917)

PROF. THEODOR KOCHER, one of the most famous of recent scientific surgeons, was born on August 25, 1841, at Bern, where he received his medical education and qualified in 1865. After a postgraduate tour abroad he returned to Bern, where he served as Lueck's assistant and succeeded him as professor of surgery in 1872. Though there is scarcely a branch of surgery to which he did not make some valuable contribution, he is best known for his work on the thyroid gland, for which he was awarded the Nobel Prize in 1911. In 1878 he was the first to excise this organ for goitre, and afterwards performed this operation on more than two thousand cases. At an early stage of his career he recognized the value of antiseptic methods, which he was the first to introduce into Switzerland. He was one of the founders of abdominal surgery, especially as regards operations on the stomach, gall-bladder and rectum. His name has been given to a method of reducing dislocation of the humerus, an operation for inguinal hernia and numerous instruments. Throughout his life he paid constant attention to anatomy and operations on the cadaver.

Kocher's principal publications were the "Operationslehre", which was translated into English, French, Italian, Spanish and Russian, lectures on surgical infections and forms of fracture. He was also the author of works on diseases of the testis and on gunshot wounds, as well as of numerous contributions to periodical literature. He received many honours in his own country, including the presidency of the Bern Medical Society, the Swiss Medical Committee and the Swiss Society of Pathology, as well as foreign distinctions such as the honorary fellowship of the Royal College of Surgeons of England and the presidency of the German Society of Surgery and of the International Congress of Surgery held at Brussels in 1905. In 1912 in honour of the fortieth anniversary of his appointment as professor he was the recipient of a *Festschrift* which formed the 116th volume of the *Deutsche Zeitschrift für Chirurgie*. He died after an abdominal operation on July 27, 1917.

Announcements

THE following appointments and promotions in the Colonial Service have recently been made: R. W. Ford, veterinary officer, Gold Coast; T. T. Threlkeld, veterinary officer, Jamaica; B. D. Evans (assistant director), director, Royal Observatory, Hong Kong.

FIVE hundred bottles of blood serum prepared at the University of Toronto in a laboratory furnished by the Canadian Government are being sent to the National Institute for Medical Research, London, for the treatment of air-raid casualties.

BY an Order of the Committee of Privy Council, made after consultation with the Medical Research Council and with the president of the Royal Society, Mr. E. Rock Carling (senior surgeon to the Westminster Hospital) and Prof. S. P. Bedson (professor of bacteriology in the University of London) are appointed members of the Medical Research Council, in succession to Prof. G. E. Gask and Prof. W. W. C. Topley, who retire on September 30.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Terminology of Relative Growth-Rates

It is generally agreed that the study of the rates of growth of parts of organisms in relation to the rates of growth of the wholes or of other parts is one of the most fruitful ways of advancing our knowledge of ontogenetic development. But these biological processes have stable end-results. Organisms differ among themselves in size, weight, proportions, etc., when at corresponding stages of their life-cycles. These differences are often expressible by the same, or similar, relations to those which describe developmental relative growth. Their study is one of the most fruitful ways of advancing our knowledge of phylogenetic development.

Satisfactory and generally accepted terminology for these comparisons has not yet been quite achieved. Some time ago, in these columns, Needham and Lerner[1] proposed that for ontogenetic relative growth the term *heterauxesis* should be used, with *isauxesis*, *tachyauxesis* and *bradyauxesis* to denote the cases where the growth of the part is at the same rate, or faster, or slower, than that of the body as a whole. The older term *allometry* was suggested for comparisons of phylogenetic character. It seems, however, that it is in the opinion of many desirable to have a covering term for both these comparisons, and this being so, we wish to suggest here that *allometry* be the covering term, and *allomorphosis* the term for phylogenetic comparisons. This indicates that all these differences are quantitative, but that on one hand they concern differing rates of growth in the individual, and on the other they concern different (morphological or chemical) patterns brought about by previous heterauxetic growth in the completed individual of different groups.

The following definitions may therefore be given:

(1) *Heterauxesis*, the relation of the growth-rate of a part of a developing organism (whether morphological or chemical) to the growth-rate of the whole or of another part; a comparison between organisms of the same group but of different ages and hence sizes.

(2) *Allomorphosis*, the relation of parts of organisms at some definite age to wholes or parts also at some definite age, but of different groups (races, varieties, species, genera), for example, egg-size or hatching-weight to adult size or weight.

(3) *Allometry*, ontogenetic heterauxesis and phylogenetic allomorphosis.

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Aug. 1.

[1] NATURE, 146, 618 (1940).

Ultra-violet Rays and Their Variations

WIRELESS operators have observed that the strength of signals received by them from distant stations varies from time to time. There is a secular variation which Sir Edward Appleton has shown coincides in general with the solar cycle[1]; there is an annual variation depending on the season; and there is a daily variation in which sunrise and sunset play a prominent part. These variations are, with high probability, effects of the ionization of the upper atmosphere and this ionization is, in its turn, produced by the ultra-violet rays from the sun. Observations of ultra-violet rays are of considerable interest in this connexion and have been carried on in one or two places for a number of years.

In order to allow for the effects of the lower atmosphere in absorbing radiation, Dr. Pettit's method[2] has been adopted in the following way.

Two groups of rays have been observed, one in the ultra-violet of wave-length around 3600 A., and the other in the visible region around 4500 A., and by taking the *ratio* of these the influence of the lower atmosphere may be neglected as a first approximation.

It has been found that there is a variation of this ratio which is in sympathy with the solar cycle[3]. There is also a variation in which there are high values in winter and lower values in summer; and now recent observations made daily, every three hours, show a variation of the ratio in which values are high at sunrise and sunset and low at midday. Curves of these seasonal and daily ratios of ultra-violet and daylight rays agree closely with each other both in form and magnitude.

Experiments on the reflexion of electromagnetic waves from the upper atmosphere show that the Kennelly-Heaviside ionized layer increases in density from winter to summer and decreases from summer to winter; in the same way there is an increase of density from sunrise to midday and a decrease from midday to sunset. These variations readily explain the fluctuations of ultra-violet rays treated as a percentage of the daylight rays. Thus, of the ultra-violet rays supplied by the sun, a part of their energy will be absorbed in the process of ionization, and the remaining part will pass on to the surface of the earth, while the visible rays which do not ionize the air pass to the surface of the earth without losing energy in this way. Now ionization by the ultra-violet rays will be approximately proportional to the altitude of the sun, and when this is high as it is in summer, or at midday, the absorption of ultra-violet rays in ionizing will be a maximum, and consequently at these times the percentage of ultra-violet radiation reaching the surface of the earth will be a minimum. Similarly, when the solar altitude is least, the percentage of ultra-violet radiation reaching the earth will be largest. This is in agreement with observation.

Thus the behaviour of ultra-violet rays and the behaviour of electromagnetic waves both yield, although in different ways, evidence of ionization in the upper atmosphere.

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July 24.

[1] Appleton, *Phil. Mag.*, Ser. 7, **27**, 144 (1939).
[2] Pettit, E., *Astro. J.*, **75**, 185 (1932).
[3] Ashworth, *Proc. Manchester Lit. and Phil. Soc.*, **83**, 81 (1939); and Pettit, *loc. cit.*

After-burning of Carbon Monoxide: Spectroscopic Evidence for Abnormal Dissociation

IN recent papers[1,2] I have discussed the cause of the after-burning and latent energy of the carbon monoxide flame in relation to the flame spectrum, and have given estimates of the lives of the vibrationally activated molecules which are formed. It was also suggested that the high vibrational energy of the newly formed molecules might result in a large amount of dissociation. Since I communicated these papers, David, Leah and Pugh[3] have published some experiments on latent energy and dissociation in flame gases which give striking support to my suggestion.

The theory of the later stages of the combustion of carbon monoxide may be summarized as follows:

(*a*) Since the dissociation products of a normal carbon dioxide molecule are not normal $CO(^1\Sigma) + O(^3P)$, but electronically excited $CO\ (^3\Omega) + O(^3P)$, the formation of normal carbon dioxide from normal carbon monoxide and oxygen must require an electronic rearrangement in the newly formed carbon dioxide molecule.

(*b*) The excited state of carbon dioxide, before the electronic rearrangement, is probably triangular, while the normal carbon dioxide molecule is known to be linear. Hence the electronic rearrangement, whether occurring by radiation or on collision, will result in the newly formed molecule acquiring a large amount of vibrational energy owing to the sudden change in shape.

(*c*) This excess vibrational energy will, if the gases are pure, persist for an appreciable fraction of a second. In the presence of moisture, however, the excess energy will be quickly transformed into thermal energy.

(*d*) For the carbon dioxide molecule the transverse vibration ν_2 and the symmetrical vibration ν_1 have frequencies which satisfy the relation $\nu_1 = 2\nu_2$ to a very close approximation. This degeneracy may result in resonance between the two vibrations and transfer of energy from one form to another, and thus may result in dissociation of the molecule if its vibrational energy content is sufficiently high.

This theory appears to explain many of the peculiarities of the combustion of carbon monoxide, such as the effect of moisture on flame speed and flame temperature, the effect of drying in increasing the infra-red radiation[4] from explosions, and the failure to observe the infra-red band at 14·9 μ.

In the recent experiments by David and his colleagues it has been shown that temperature measurements of flames made with wires coated with quartz indicate an abnormally high dissociation of the CO_2 molecules, this being greatly in excess of the dissociation expected at the flame temperature. If the newly formed carbon dioxide molecules are vibrationally activated, as indicated by the theory above, they may be regarded as having a very high effective vibrational temperature, this being much greater than their effective translational temperature. Since it is the vibrational temperature which determines the dissociation of the molecules, it is to be expected that the vibrationally excited molecules formed by the combustion will show an abnormally high dissociation.

The afterglow of carbon dioxide in a discharge tube[5] and the after-burning should both be regarded as manifestations of this dissociation, the usual flame spectrum being emitted during the recombination processes following the dissociation. The emission of light during the after-burning or afterglow should not be regarded as due to emission from activated (metastable) molecules, which have not sufficient energy to give a spectrum in the ultra-violet[6], but as due to the flame of gases which are recombining following the abnormal dissociation. Increase of pressure will increase the light emission from the after-burning gases by altering the dissociation equilibrium; Prof. A. C. G. Egerton points out that this is supported by observations of the increased luminosity at the centre during explosions in closed vessels when the pressure wave travels back through the burnt gases.

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July 24.

[1] Gaydon, A. G., *Proc. Roy. Soc.*, A, **176**, 505 (1940).
[2] Gaydon, A. G., *Proc. Roy. Soc.*, A, **178**, 61 (1941).
[3] David, W. T., Leah, A. S., and Pugh, B., *Phil. Mag.*, **31**, 156 (1941).
[4] Garner, W. E., Johnson, C. H., and Saunders, S. W., NATURE, **117**, 790 (1926).
[5] Fowler, A., and Gaydon, A. G., *Proc. Roy. Soc.*, A, **142**, 362 (1933).
[6] Egerton, A., and Ubbelohde, A. R., NATURE, **134**, 848 (1934).

"White Horses"

THE behaviour of secondary waves riding on the larger primary ones does not seem to have been taken into account in the theory of wind-formed sea waves. From the geometry of trochoids, surface water particles at the troughs on either side of the crest of a secondary wave will close up when this wave is riding on the crest of a primary one, and open out at its trough. The energy of the secondary wave will squeeze up and disperse accordingly; and height, and so steepness, will be affected not only on that account, but also because the relationship of height to energy will change owing to the vertical acceleration of the water caused by the primary wave.

Thus, if L, H, S, E denote length, height, steepness and energy per sq. ft. of water surface of the primary wave, S being taken as $H \div L$, and l, h, s, e apply to the secondary wave, l will range from $l \times (1 - \pi S)$ at crest, to $l \times (1 \times \pi S)$ at trough; e from $e \div (1 - \pi S)$ to $e \div (1 + \pi S)$; and W from $64 \times (1 - \pi S)$ to $64 \times (1 + \pi S)$ lb. per cu. ft. Therefore, as $e = W.h^2 \div 8$, h will range from $h \div (1 - \pi S)$ to $h \div (1 + \pi S)$, and s from $s \div (1 - \pi S)^2$ to $s \div (1 + \pi S)^2$. It will be noticed that this deformation is independent of the steepness of the secondary wave, and of whether that wave is moving with or against the primary one.

It is commonly assumed that 'white horses' are due to the wind blowing off the tops of the primary waves, and that may be partly true. But they are apt to persist for some time after the wind has completely dropped, so must also be accounted for by the steepening, and consequent breaking, of secondary waves when the crests of the primary ones are passing under them. To reduce the problem to figures, let L, H, S be 200 ft., 5 ft. and 0·025, and let l, h, s be 20 ft., 2 ft. and 0·10, on the average. s will increase from that average value to almost 0·12, which is not far off Wilton's theoretical limit[1] of 0·13, a figure which may not necessarily always be attained, for waves have but a small margin of stability as they approach breaking point.

Further, it seems to be common experience that a nasty lop gets up with great rapidity when wind starts to blow against a swell, and this may be accounted for by the effect described.

The above applies to deep water. When the primary waves run into shoal water, the horizontal movement of the water particles is increased, and so the length and height of secondary waves, when they are riding on primary crests, are respectively decreased and increased to greater extents than before. There will only be secondary waves when there is an onshore wind, and then these waves will break more easily after the primary ones feel the bottom than they did before; and when they do break they will create disturbances which may initiate the breaking of the primary waves. This may be an explanation of the conclusion arrived at by Gaillard[2], who made many observations to determine the ratio of D (depth of water) to H necessary to cause breaking. He found that "for a given locality and given slope [of bottom] variations in the ratio of D to H appeared to be due almost entirely to the direction and force of the wind", and that while with a strong onshore wind the ratio might be 1·25, an offshore wind reduced the figure to 0·72.

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[1] *Phil. Mag.*, (6) 23, 1055 (1913).
[2] Gaillard, "Wave Action in relation to Engineering Structures", p. 120.

Transmission of *Leishmania tropica* by the Bite of *Phlebotomus papatasii*

SANDFLIES *Phlebotomus papatasii* ♀ were infected with *Leishmania tropica* by feeding through a membrane on a suspension of flagellates in 3 parts of 2·7 per cent saline and 1 part inactivated defibrinated rabbit blood.

They were afterwards refed on eight human volunteers, of whom five have so far become infected with cutaneous leishmaniasis as a result of bites from twenty-six infected sandflies. Twenty-six infected sandflies produced twenty-eight individual lesions, of which twenty-seven were produced by eleven sandflies only.

This experiment differed from previous negative experiments only in that the sandflies were kept at a temperature of 30° C. and that they were infected by feeding on a suspension containing 2·7 per cent saline instead of normal physiological saline. Full details will be published elsewhere.

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Evolution in the Genus Pæonia

THE genus Pæonia has three main centres of distribution and diversity: in the Mediterranean and Black Sea basins, in the Far East from Tibet to Japan, and in North America. From my own and previous chromosome studies[1,2,3], I find that in these separate regions it has undergone three different methods of species formation, all the time working with the same haploid set of five chromosomes.

In the Mediterranean area are a group of small-range diploids ($2n = 10$). Most of these diploids, apparently by simple doubling, have given rise to large-range tetraploids ($2n = 20$) usually lying to the north of their progenitors. Three of these large-range tetraploids, namely, *arietina* and *peregrina* in the Balkans and Asia Minor, and *coriacea* in southern Spain and Morocco, have no nearly related diploids; apparently their ancestors have failed to survive (see accompanying table).

SPECIES IN PÆONIA

	2x	4x
Europe	*Mlokosewitchii* (Caucasus) →	*Witmanniana* and varieties (Caucasus)
	daurica (Crimea, etc.) →	*mascula* (scattered)
	Clusii (Crete) →	*officinalis*, *humilis* and (N. Mediterranean) vars.
	Cambessedesii (Balearics) →	*Russii* and vars. (Western islands of Mediterranean)
	2 other localized species in Mediterranean 1 widespread in Ukraine	3 other widespread species unrelated to any surviving diploids
Asia	*japonica* (Japan) →	*obovata* and varieties (E. Asia)
	8 other widespread diploids	No other tetraploids
N. America	2 diploids	No tetraploids

It thus seems that the advancing ice had driven the diploid species into Mediterranean peninsulas and islands, and from these isolated fragments of pre-glacial species Europe was afterwards recolonized by more vigorous, or perhaps more adaptable, tetraploids as the ice retreated. The kind of adaptability is shown in some cases to consist in stronger tuber development.

In Asia, on the other hand, there has been no such impassable barrier to movement back and forth, and we find a number of diploid species—some covering a large range, for example, *P. lactiflora* and *P. anomala*—and only one tetraploid, *P. obovata*. This species again is in the north (Manchuria and eastern Siberia), but it seems that the diploids, never having been restricted in population and variation, have themselves been able to meet the opportunity of colonization and to follow the retreating ice northwards.

In the smaller territory of California and Oregon a smaller population shows yet another system of variation. Only two species are recognized, and both of them are true-breeding diploid hybrids of the kind known in Œnothera. Instead of having five bivalents at meiosis they have rings of six, eight or ten chromosomes[3].

Thus in the three regions Nature seems to have carried out an experiment in variation and selection which helps us to understand how different conditions, partly external and partly perhaps internal, can lead to different methods of evolution in members of one genus.

I wish to thank Major F. C. Stern for much of the material on which this investigation was made. All the details of the geographical distribution will be found in his forthcoming monograph[4].

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July 23.

[1] Dark, S. O. S., *J. Genet.*, 32, 353 (1936).
[2] Sinoto, Y., *Cytologia*, 9, 254 (1938).
[3] Stebbins, J. L., and Ellerton, S., *J. Genet.*, 38, 134 (1939).
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Defence of Source of Food by Bees

IT is well known that worker bees defend their hives against individuals from other stocks. So far, however, there seem to be no reports of bees defending their feeding grounds. The following observations indicate such behaviour. Light pure Italians from a particular stock were fed on a training-table and marked individually according to von Frisch's[1] methods. The food was cane sugar dissolved in twice its weight of water and was poured on sand in a Petri dish. After several days no food was offered for one day. Great numbers of marked bees were observed digging eagerly and persistently in the dry sand and searching the neighbourhood for many hours. Scouting black Caucasians which might have had an occasional drop of syrup on the previous day frequently approached the Petri dish, but although they appeared to be of heavier build, they were invariably attacked and driven away. Of the 217 encounters observed, not a single one was won by the Caucasians. One particular Italian bee which had been treated with hydrocyanic acid the previous day attacked twenty-six times, generally carrying the Caucasians away and stinging at least three of them. Another Italian won twelve duels. If food is offered the pugnacity of the bees is much reduced, but intruders are still chased away.

From a second experiment it appeared that Caucasians similarly trained and marked could equally well defend their feeding-place against I alian intruders. It was remarkable that the same marked Italian bees, which had previously defended their dish so well, were invariably driven away by the Caucasians. It seems that the different smell and the uncertain behaviour of the newcomers arouses the pugnacity of the other group when food becomes scarce. It is possible to train Italian and Caucasian bees simultaneously at the same dish of food. As long as there is plenty of syrup nothing much happens, but when the sand becomes dry a general battle ensues.

In a third experiment Italians from two hives were fed on the same dish and marked differently. When the food became scarce occasional encounters between workers of the two groups were observed, but the fighting was far less intense, and some bees from both hives could be seen digging in the sand side by side for a considerable time. At the same time Caucasian intruders were fiercely driven away, sometimes by the combined efforts of the Italians from different hives. Caucasians from different hives also do not fight one another very intensely. It seems therefore that, in contrast to the defence of the hive, which is defended against all intruders, a bigger racial difference between bees is necessary to induce fighting for the source of food on a large scale. It would be interesting to investigate the behaviour of the offspring of crosses of the two bee races.

Thus collecting bees from a hive take possession of a particular feeding ground and defend it in the circumstances mentioned above against intruders, especially when of a different race, in a way similar to that described for fish, birds[2] and other animals. This result should be borne in mind by anybody attempting to compare the collecting habits of workers of different bee races.

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Aug. 2.

[1] Frisch. K. V., "Abderhaldens Hdb.", Abt. 5, 365 (1921).
[2] Howard, E., "Territory in Bird Life", John Murray, London (1920).

Discovery of *Mysis relicta* in Ennerdale

ON June 19 a single living specimen of *Mysis relicta* was found in Ennerdale Water accidentally trapped in one of a series of funnels which are suspended at various depths to catch the sediment from the overlying water. Although this 'relict' crustacean has been recorded from Loughs Neagh, Erne and Derg in Ireland, this is the first time it has been recorded from Great Britain. It is particularly noteworthy also that it should have been taken in Ennerdale Water as this lake is the only known British locality for another 'relict' crustacean, namely, the copepod *Limnocalanus macrurus* Sars. That there was just a possibility of the occurrence of Mysis in the lake had been realized ever since the discovery of Limnocalanus, but all attempts to obtain specimens had been unsuccessful. The intriguing problems of modification, distribution and geology raised by the occurrence of Limnocalanus in Ennerdale Water have been discussed by Dr. Gurney in his papers on "The Crustacean Plankton of the Lake District"[1], and on "Ennerdale Water: A Problem for Geologists"[2], and the same problems, of course, are still further emphasized by the discovery of Mysis in the lake.

Outside the British Isles these two crustaceans occur, very often together, in many lakes of the Baltic region and in the region of the great lakes of North America, and it seems certain that they have been modified from the marine species *Limnocalanus grimaldi* (De Guerne) and *Mysis oculata* Fabricius since the close of the glacial epoch. Their occurrence, therefore, in Ennerdale Water, some 360 ft. above sea-level, evidently calls for renewed consideration by both zoologists and geologists. It is proposed to endeavour, as soon as practicable under present conditions, to obtain further specimens of Mysis from Ennerdale especially with the view of finding out whether the animals there have developed any distinctive racial characters as compared with other representatives of the species in Ireland and elsewhere.

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Aug. 7.

[1] *J. Linnean Soc.*, Zool., 35, 411–447 (1923).
[2] *Discovery*, 9 (December, 1928).

DEUTERON-INDUCED FISSION*

MECHANISM OF DEUTERON-INDUCED FISSION

By Prof. N. Bohr, For.Mem.R.S.

Institute of Theoretical Physics, University of Copenhagen, May 8

In nuclear transformations initiated by deuteron impact, two types of processes are, as well known, to be taken into consideration. In the process of the first type (process I), the intermediate state is formed by the capture of the whole deuteron by the nucleus; in the process of the second type (process II), the deuteron breaks up during the impact with the result that the proton escapes and only the neutron is taken up in the compound nucleus. As originally pointed out by Oppenheimer and Phillips[1] and more closely discussed by Bethe[2], the cross-section for the formation of the compound system may, in certain circumstances, be considerably larger in process II than in process I. Still, a clear discrimination between the two types of processes by means of ordinary nuclear transformations seems so far to have met with difficulties, and it may, therefore, be of interest to point out that the study of deuteron-induced fission of heavy nuclei offers new possibilities for such a discrimination.

Not only is fission easily distinguished from other possible transformations but, in particular, a certain critical excitation energy different for different nuclei is necessary for fission to occur. Just as regards the excitation of the compound nucleus, the processes I and II differ essentially. While the excitation obtained by process I will be far greater than the neutron binding energy for all nuclei concerned, it will, in process II, on the average be smaller than this energy. Since, for the abundant uranium isotope, as well as for thorium, the critical fission energy is higher than the neutron binding energy, it was concluded[3] that a considerable output of nuclear fission in thorium and uranium could only be expected in processes of type I. Even if, in certain deuteron energy regions, processes of type II should be more probable, they would almost entirely result in a permanent capture of a neutron with formation of radioactive uranium and thorium isotopes with well-known periods.

One of the possibilities of testing these arguments is offered by a comparison between the fission yields in uranium and thorium. This is possible because the probability of fission of the compound nucleus in process I may be estimated with a high degree of approximation. In fact, the excitation energy in process I will not only be sufficient for fission to occur in competition with neutron escape, but even the excitation of the residual nucleus left after the escape of a neutron will be large enough to make a fission quite probable. The total probability for fission of the compound nucleus in such successive transformations was thus estimated[4] to be nearly 1 for uranium and about 0·8 for thorium. These expectations seemed confirmed by the experiments reported by Jacobsen and Lassen[5] who found that the ratio of the fission cross-sections in uranium and thorium at 9-Mev. deuteron energy was approximately 0·7.

In a later discussion of these experiments[6], however, it has been realized that the cross-section for the formation of the compound system in process I, because of the smaller nuclear charge, must be expected to be 25 per cent greater in thorium than in uranium. If the whole fission effect in both elements was due to processes of this type, the theoretically estimated ratio of the fission yields in thorium and uranium should, consequently, instead of 0·8, be about 1·0. The difference between this last figure and the measured value 0·7 seems too great to be explained, unless it is assumed that a considerable part of the effect, at any rate in uranium, is due to processes of type II. A support of this conclusion is also offered by a closer comparison of the fission effects in thorium and uranium for smaller deuteron energies. Thus, in the experiments of Jacobsen and Lassen the fission cross-section for deuteron energies about 8 Mev. is relatively higher in uranium than in thorium, as would be expected if a part of the effect in uranium sets in for lower energy values.

A contribution of process II to the fission effects which is relatively greater in uranium than in thorium may be expected from the fact that the critical fission energy of the compound nucleus for thorium is almost 2 Mev. higher than the neutron binding energy, while, for the abundant uranium isotope (238), the difference is smaller than 1 Mev. Moreover, in the energy region concerned, where the fission cross-section is less than 1 per cent of the geometrical nuclear cross-section, it is possible that a not inconsiderable contribution is due to the lighter rare uranium isotope (235). Since, for this isotope, the critical fission energy of the compound nucleus in process II is about 1 Mev. lower than the neutron binding energy, the probability of fission may, for the low excitations obtained by such a process, be far greater than for the heavy isotope.

To clear up the different questions raised, it would be very desirable that experiments on deuteron-induced fission be extended to a region of greater deuteron energies, and, especially, that such experiments be performed with separated uranium isotopes and with protactinium, for which the critical fission energy of the compound nucleus is nearly equal to the neutron binding energy[7].

[1] Oppenheimer, J. R., and Phillips, M., *Phys. Rev.*, **48**, 500 (1935).
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[3] Bohr, N., and Wheeler, J. A., *Phys. Rev.*, **56**, 449 (1939).
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[5] Jacobsen, J. C., and Lassen, N. O., *Phys. Rev.*, **58**, 867 (1940).
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FISSION CROSS-SECTION IN URANIUM AND THORIUM FOR DEUTERON IMPACT

By J. C. JACOBSEN AND N. O. LASSEN

Institute of Theoretical Physics, University of Copenhagen. May 8

As reported in a previous note[1], experiments have been carried out with the cyclotron in this institute to investigate the cross-section for fission in thorium and uranium produced by impact of deuterons with different energies. The fission outputs were determined by collecting the radioactive fragments on aluminum foils facing the targets and screened from the deuteron beam. Because of the difficulty of estimating the number of fission processes from the β-radioactivity of these foils, a considerable uncertainty, however, was involved in the determination of the absolute value of the fission cross-section.

In continued experiments, this uncertainty has been reduced by a calibrating procedure in which two thin uranium targets were exposed to neutron impact. One of the targets was placed in a small ionization chamber and the number of fission particles emitted from this target counted by a linear amplifier. The fission particles from the second target were collected on a thin lead foil; the distance between the two targets was sufficiently small to ensure that the neutron intensity was very nearly the same. By measuring the activity of the collecting foil with the same counting arrangement as in the experiments with deuterons, the ratio between the foil activity and the number of fission particles emitted during the irradiation could thus be determined.

Instead of the preliminary value of $0 \cdot 5 \times 10^{-26}$ cm^2 given in the previous note, the measurements thus calibrated gave now the value $(2 \cdot 2 \pm 1) \times 10^{-26}$ cm.^{2} for the fission cross-section in uranium at 9-Mev. deuteron energy. The results found for the variation of the cross-section with deuteron energy and the ratio between the cross-sections in thorium and uranium given in the note remain, of course, unaltered. From the value 0·7 for the last ratio, which agrees with the independent determination by Krishnan and Banks[2], we obtain in consequence $(1 \cdot 5 \pm 0 \cdot 7) \times 10^{-26}$ cm^2 for the fission cross-section in thorium at 9-Mev. deuteron energy.

Details of the experiments are described in a paper in print in the *Communications of the Copenhagen Academy of Sciences* where, also, a description of the cyclotron has just been published[3].

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EDUCATIONAL PROGRESS IN THE UNITED STATES

By R. WEATHERALL

ETON COLLEGE

IN recent years, C. V. Good, of the University of Cincinnati, has made a practice of preparing an annual review of educational progress in the United States[1]. In his report for 1940 his method has been to compile a list of educational issues, and then to cite illustrations of the manner in which they are being met. These issues may be summarized as follows:

DEMOCRATIC SOCIETY AND PUBLIC EDUCATION

A great deal of thought is being given to the problem of education for good citizenship in a democratic society. To achieve such an aim requires individuals who have respect for other people, a concern for group problems, and a willingness to use intelligence in problem solving. In dealing with educational matters there is a marked tendency towards co-operative effort. This includes the pooling of ideas by teachers and administrators, and extensive use is being made of joint discussions between teachers and students. In this way the students themselves are being encouraged to ask and answer questions which should help them to evaluate current social, economic and political trends, and to establish helpful relations with other members of the community.

EDUCATION AND THE EMERGENCIES OF NATIONAL DEFENCE

Almost to a greater extent than in Great Britain, teachers and the general public alike in the United States are giving consideration to the repercussions which the present world crisis is having upon the educational field, and to the extent to which by educational means support may be given to the national effort. As the report points out, education is called upon to defend human resources, culture, and American democratic processes, as well as to assist in the material defence of the community and nation. Federal participation in education is extending, and in the service of youth, unification in Federal policy is being brought about in the spheres of health, education, and social welfare.

YOUTH PROBLEMS AND CURRICULUM

Under this heading consideration is being given to the needs of the large number of pupils who will not proceed to college, and who do not require specific technical training. The problem of the responsibility of the community towards young people between the ages of eighteen and twenty-one, who cannot be readily absorbed into industry, is also receiving attention. The United States Employment Service is concerning itself with the adjustment of school-leavers to suitable occupations, and with the best way of enabling young people to enter upon rural life. Other investigations are dealing with the specific problem of Negro students: their development during adolescence, and their status in the existing social and economic order.

To a far greater extent than occurs in the British Isles, public opinion makes itself directly felt in educational policy, and recourse is being made to the

American Institute of Public Opinion. On this point it is interesting to note that a large majority of the public do not feel that education is over-emphasized, although the school-leaving age is some two to three years higher than in England. The large proportion of pupils remaining at school into their middle teens is leading to increased attention being given to individual aptitudes and preferences. As an institution the school is not so directly tied to the college. Freedom from prescribed college requirements has acted as a challenge and a stimulus to the school, and has resulted in a period of great educational growth.

A programme to make science teaching answer the needs of young people has been organized by the Bureau of Educational Research in Science at Teachers' College, Columbia University. This investigation is being carried out on a comprehensive scale, and should lead eventually to conclusions of great significance.

Appraisal and Implementation

As indicated above, educational institutions in America cannot be considered in any way as being tied down by tradition. Not only are they very closely in touch with public opinion, but also continuous discussion is taking place between administrators, teachers, and students as to educational aims and the extent to which they are being achieved. Educational policy thus becomes dynamic, itself the subject of rational investigation, and capable of readjustment from time to time. The Evaluation Study of Bennington College, for example, is intended to be a permanent feature of the College. It is planning to investigate the nature of the College's total educational programme, how this programme developed, the purposes behind the programme, the assumptions underlying the purposes, to what extent these purposes are being realized, and the changes which staff and students consider should be made for the College to achieve its aims more effectively.

Teacher Education

There is little danger that standards among teaching personnel are likely to decline during the present emergency. The spread of examination tests is bringing about some standardization with regard to qualifications, which makes for facility in the selection of candidates. But with the extension of a national system of examinations there arises the risk that examinations may become an end in themselves, not merely the means, and so lay themselves open to commercial exploitation.

The Social Pole of Science and of the Man of Knowledge

The report points out that it is high time that the social responsibilities of scientists and of research workers be recognized and accepted. In the past, emphasis on material production and on the instruments of war has led to technological unemployment and to the partial neglect of problems of human welfare, health, domestic life, and education, with the biological and social sciences starved in deference to the more immediately profitable physical and chemical sciences. Since science and research are determining factors in the destiny of mankind, a social policy for science must be formulated to guarantee that such knowledge will be used for the welfare of society.

[1] *School and Society*, vol. 53, no. 1368.

THE BRITISH COUNCIL

The report of the British Council covering the year ended March 31, 1941*, pays a warm tribute to the work of Lord Lloyd. The Council has recognized two main duties, first, the defensive role in the resistance to and disproval of charges brought against us by German and Italian propaganda and, second, the positive mission of carrying to other countries a knowledge of the contribution which Great Britain has made and still makes towards the science of life and government.

The chief methods adopted by the Council for this purpose are the formation of new or the encouragement of existing British cultural centres abroad, and the Council is now responsible for British Institutes in Malta, Cyprus, Palestine, Egypt, Iraq, Spain and Portugal. Most of the anglophil societies encouraged by the Council are now found in Latin America although before the War the Council was in touch with no less than 250 such societies, many in France, Germany, the Netherlands and Scandinavia. The Council also encourages British schools abroad as well as English studies in foreign schools and universities, and throughout these institutions and elsewhere the knowledge of the English language. Competitive scholarships, valued at £250, are awarded to well-qualified post-graduate students from foreign countries and from the Empire.

Such activities have been inevitably modified by the War. One of the Council's main tasks has been to build up in the premises of the anglophil societies of British institutes and also in foreign universities and other institutions general libraries of English books and to this has been added the presentation of scientific and technical works to specialist libraries abroad. A book export scheme has been initiated to encourage the sale abroad of British books of cultural importance as well as a book review scheme intended to secure the review of British books in foreign newspapers and periodicals.

A small fortnightly publication has been issued since March 1939 under the title *Britain To-day*, containing generally an editorial and three articles written for the foreign reader on subjects which may be expected to be of interest to him. Reference is also made to the work of the Council in regard to films, particularly the commission of documentary films on carefully chosen subjects dealing with British life and achievements and the commission or

* The British Council. Report for 1940–1941. Pp. 176. (London: The British Council, 1941.)

acquisition of films intended for educational purposes abroad or describing scientific or technical achievements which it is desired to make known abroad. An Advisory Scientific Committee has also been formed which it is intended should work in three or more panels, one under the chairmanship of Sir William Bragg dealing with pure science, a second under the chairmanship of Sir Edward Mellanby dealing with medicine, and a third under the chairmanship of Sir William Larke dealing with engineering. Sir William Bragg is also chairman of the Advisory Scientific Committee as a whole.

Previously, the Council's interest in scientific publicity was shown chiefly in co-operation with the British Medical Information Service, the dispatch of a number of scientific and learned periodicals and books abroad including a complete section of the South American Book Exhibition, the preparation of a Spanish hand-book of British industrial practice, in conjunction with the British Standards Institution, and the presentation of equipment to a hospital in Sana'a and to a bacteriological institute in Chile.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

Friday, August 29

ASSOCIATION OF SCIENTIFIC WORKERS (at Conway Hall, Red Lion Square, London, W.C.1), at 6.30 p.m.—Open Meeting on "Science and the Soviet Union". (Speakers: Dr. Joseph Needham, F.R.S., Dr. Martin Ruhemann, and others.)*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, and a LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (August 30).

HEAD OF THE SCIENCE DEPARTMENT OF THE BLACKBURN MUNICIPAL TECHNICAL COLLEGE—The Director of Education, Education Offices, Blackburn (August 31).

HEAD OF THE ENGINEERING DEPARTMENT OF THE BLACKPOOL TECHNICAL COLLEGE—The Director of Education, Education Department, Caunce Street, Blackpool (September 1).

(a) ASSISTANT ENGINEER and (b) an ENGINEERING ASSISTANT—The Engineer to the River Great Ouse Catchment Board, Elmhurst, Brooklands Avenue, Cambridge (endorsed 'Appointment (a) or (b)') (September 1).

HEADMISTRESS OF THE KENYA HIGH SCHOOL FOR GIRLS, NAIROBI—The Secretary (I.P.B.), Board of Education, Alexandra House, Kingsway, London, W.C.2 (September 1).

LECTURER FOR THE MECHANICAL ENGINEERING DEPARTMENT—The Principal, Merchant Venturers' Technical College, Bristol (September 2).

DEPUTY BOROUGH ELECTRICAL ENGINEER to the Great Yarmouth Corporation—The Engineer and General Manager, Electric House, Regent Road, Great Yarmouth (September 5).

ENGINEER to the Lower Medway Internal Drainage Board—The Clerk to the Board, 71a Bank Street, Maidstone (September 13).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 1, No. 5: On Cardiopteridium, a Genus of Fossil Plants of Lower Carboniferous Age, with Special Reference to Scottish Specimens. By Prof. John Walton. Pp. 59–66+1 plate. 1s. Vol. 61, Part 1, No. 6: Mutation and Lethal Effects of Ultra-Violet Irradiation on *Drosophila*. By Dr. K. Mackenzie. Pp. 67–77. 1s. (Edinburgh and London: Oliver and Boyd.) [58

The Scientific Journal of the Royal College of Science. Vol. 11: Containing Papers read during the Session 1940–1941 before the Imperial College Chemical Society, the Royal College of Science Mathematical and Physical Society. Pp. viii+94. (London: Royal College of Science.) [58

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. War Food Production, Advisory Bulletin No. 5: Seeds Mixtures. By M. T. Thomas. Pp. 22. (Aberystwyth: Welsh Plant Breeding Station.) 1s. [58

Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research to the Annual General Meeting, 17th July, 1941. Pp. 30. (Edinburgh: Scottish Society for Research in Plant-Breeding.) [58

Scientific Proceedings of the Royal Dublin Society. Vol. 22, No. 40: The Effect of Wave-Length on the relation between the Intensity of Illumination and the Current in Selenium Rectifier Photo-Cells. By H. H. Poole and W. R. G. Atkins. Pp. 393–398. 6d. Vol. 22, No. 41: Atmospheric Pollution in Dublin during the Year 1940. By A. G. G. Leonard, Bridget P. McVerry and D. Crowley. Pp. 399–404. 6d. Vol. 22, No. 42: Estimation of Ammonia and Urea by a Modification of the Conway Diffusion Method. By Einhart Mawerau. Pp. 405–414. 1s. Vol. 22, No. 43: The Phenol Amidine Reaction; the Detection of Guanidine, Guanidine Derivatives, and Urea, by means of Thymol and Hypochlorite. By William Robert Fearon. Pp. 415–422. 6d. Vol. 22, No. 44: The Hydrolysis of Laminarin; Isolation of a New Glucose Disaccharide. By Dr. Vincent C. Barry. Pp. 423–430. 6d. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [58

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 1, No. 7: The Genetical and Mechanical Properties of the Sex Chromosomes, 8: The Cat (*Felis domestica*). By Dr. P. C. Koller. Pp. 78–94. 1s. 6d. Vol. 61, Part 1, No. 8: The Structural Differentiation of Chromosome IV of *Drosophila simulans* and its Behaviour in *melanogaster* Genotype. By Dr. B. M. Slizynski. Pp. 95–106. 1s. (Edinburgh and London: Oliver and Boyd.) [68

Institution of Automobile Engineers. Fatigue Failure of Crankshafts: Interim Report by C. G. Williams and J. S. Brown. (No. 8800. B, Class 262, 52.) Pp. 22. Durability of Gears. First Interim Report by H. D. Mansion. (No. 9153. B, Class 336, 42, 55.) Pp. 24. Engine Bearing Temperatures: Road Tests. (No. 9167. B, Class 278, 192.) Pp. 4. Engine Bearing Temperatures: Bench Tests. (No. 9166. B, Class 278, 192.) Pp. 4. (London: Institution of Automobile Engineers.) [68

Other Countries

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 31, Memoir No. 1: Upper Palæozoic Faunas of North Sikkim. By Dr. Helen M. Muir-Wood and Dr. Kenneth P. Oakley. Pp. iv+98+4 plates. (Calcutta: Geological Survey of India.) 5 rupees; 8s. [18

Journal of the Indian Institute of Science. Vol. 23A, Part 8: Attempts towards Synthesis of Cantharidin, Part 3: Condensation of Ethyl $\beta\beta'$-Diketotetrahydrofuran-$\alpha\alpha'$-Dicarboxylate with α-Bromo Esters. By B. H. Iyer and P. C. Guha. Pp. 159–168. 12 annas. Vol. 23A. Part 9: Azo-Dyes; Coupling of 5-Hydroxy-3-Amino-1:1-Dimethyl-$\Delta^{3:5}$-Dihydrobenzene with Diazonium and Tetrazonium Compounds. By Balkrishna H. Iyer. Pp. 169–174. 10 annas. Vol. 23A, Part 10: Condensation of C-Acetyl Methone with Aromatic Aldehydes. By Balkrishna H. Iyer. Pp. 175–182. 12 annas. (Bangalore: Indian Institute of Science.) [58

Ceylon. Sessional Paper 16, 1941: Report and Accounts of the Coconut Research Scheme for 1940. Pp. 18. (Colombo: Government Record Office.) 25 cents. [58

Bulletin of the Bingham Oceanographic Collection. Vol. 7, Art. 4: Plankton Studies, 4: Georges Bank. By Gordon A. Riley. Pp. 74. (New Haven, Conn.: Yale University.) 1.10 dollars. [58

Potassium. A Symposium held by the Royal Society of New South Wales, August 7, 1940. Pp. 32. (Sydney: Royal Society of New South Wales.) [58

Forty-third Annual Report of the Carnegie Museum for the Year ended December 31, 1940. Pp. 50. (Pittsburgh: Carnegie Institute.) [58

Commonwealth Prickly Pear Board. The Biological Campaign against Prickly Pear. By Alan P. Dodd. Pp. iv+177+37 plates. (Brisbane: Government Printer.) [58

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 107: Food Composition Tables. Compiled by Hedley R. Marston and Mary C. Dawbarn. Pp. 36. (Melbourne: Government Printer.) [58

U.S. Department of Agriculture. Circular No. 605: The Internal Application of Chemicals to Kill Elm Trees and Prevent Bark-Beetle Attack. By R. R. Whitten. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents. [58

Records of the Geological Survey of India. Vol. 76, Bulletins of Economic Minerals, No. 2: Chromite. By A. L. Coulson. Pp. 30. (Calcutta: Geological Survey of India.) 10 annas; 1s. [68

Report of the Botanical Survey of India for 1939–40. Pp. 18. (Calcutta: Government of India Press.) [68

Union of South Africa: Department of Agriculture and Forestry. Science Bulletin No. 227 (Locust Research Series No. 8): Laboratory Experiments on the Improvement of Poison Baits for Hoppers of the Red Locust, 1936–37. By C. du Plessis and M. C. A. Nolte. Pp. 44. 3d. Science Bulletin No. 230 (Locust Research Series No. 9): Laboratory Experiments on Poison Baits for the Brown and Red Locust, 1937–38. By A. Lea and M. C. A. Nolte. Pp. 56. 6d. Chemistry Series No. 164: Poisoning by Arsenic in South Africa. By Dr. P. R. van der Riet Copeman and Dr. P. A. E. Kamerman. Pp. 16. (Pretoria: Government Printer.) [68

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NATURE

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AUG. 30, 1941

INTERNATIONAL COLLABORATION

A SIGNIFICANT feature of the discussions of post-war international reconstruction during the past year has been the renewed attention given to the League of Nations. Federal Union and other proposals for regional or world federation no longer hold the stage to the exclusion or disparagement of the League. The tendency is rather to re-examine the causes of the League's failure, to appraise more critically its achievements, and, indeed, to regard it as the starting-point of political thought and action in the field of international reconstruction.

Powerful support to that tendency has been given by Viscount Cecil's autobiography, "A Great Experiment"*. Growing recognition of the importance of economic factors in international reconstruction has directed fresh attention to fields in which the League and the International Labour Organisation have been responsible for solid achievements. Even among those who are protagonists of power politics and most sceptical of the acceptance by States of limitations on their power or sovereignty this is appreciated. Prof. E. H. Carr, in "The Twenty Years' Crisis", considers that the best hope of progress towards international reconciliation lies along the path of economic reconstruction, while in his valedictory report to the International Labour Office, Mr. J. G. Winant points the same way with great force.

"The cornerstone of the future", Mr. Winant writes, "is already apparent from the mistakes of the past. Political democracy must be broadened to include economic stability and social security. The waste of resources which has been effectively eliminated in time of war must not be allowed to return once peace has come. An unemployed or poorly employed citizenry is no basis for winning the peace. Even though, at a moment when the survival of democracy is in the balance, priority of production, energy and will must be granted to the waging of the war itself, we must not lose sight of this conclusion from the past. No opportunity to enlarge the social content of democracy must be lost. No opportunity to strengthen the fundamental social and civil rights of the great majority of citizens must be neglected. No opportunity to wipe out the want and the hopelessness of the pre-war period must be ignored. This is not only prudent national defence, it is the tradition of democratic freedom."

Mr. Winant's conclusions from experience of recent years are important. First, he says, it is clear that the democracies cannot survive unless

* A Great Experiment. By Viscount Cecil. Pp. 384. (London: Jonathan Cape, Ltd., 1941.) 16s. net.

they can achieve effective co-operation between Governments and organizations of employers and workers. In this matter of evolving new democratic machinery and institutions, he sees, in the co-operation already developed to further our war effort, the hope of extending the force of democracy everywhere. Secondly, divisions within the ranks of the workers greatly aided the spread of Fascism in Europe, and thirdly, he urges caution in making sweeping generalizaticns on the causes of events. Those who blame social policy for the disasters that overtook France, for example, he considers, are mixing cause and effect, and he sees danger in the tendency to blame workers' organizations for inefficiencies of national economic organization and for military failures.

Mr. Winant's report is both outspoken and optimistic, and both Great Britain and the United States have reason to be thankful that a man of the vision and wisdom revealed in this report plays so large a part in their common counsels. Mr. Winant points to the way in which the War itself, having become the dominant factor in social change, is in some countries tending to promote health measures, social security legislation, and safety precautions as an integral part of national defence programmes. That is true, however, only for the Allied countries, where the democratic ideals are valid, human personality is respected, and freedom of speech, of thought, and freedom to worship as conscience dictates, are possible.

Convinced that the International Labour Organisation has an essential part to play in building the foundations for a peace based on social and economic freedom, Mr. Winant is confident that the Organisation can strengthen the fabric of democracy and make an outstanding contribution to the mobilization of the full strength of democracy. Useful as its machinery may be in helping to adapt existing social standards to war needs and to appraise hastily improvised methods of meeting war strains on the economic and social structure, its value in the preparation for the peace is far greater.

When that time comes, we must be far more ready than we were at the end of the War of 1914–18. Social and economic problems will necessarily be in the foreground, and their solution demands careful technical preparation as well as co-operation between economic and social groups and the Government, in which the experience of the International Labour Organisation and its triparitet machinery will be of great value. It can help to plan for an orderly demobilization of war and defence industry and of military forces, and in the elaboration of the basic principles which must be included in a revised labour code.

In Mr. Winant's mind the International Labour Organisation is not merely a successful experiment. It is an effective instrument for orderly social change, the capacity of which has been proved. That, indeed, is essentially Lord Cecil's verdict on the League's work in economic and social affairs. He pays emphatic tribute to the value of its technical organizations, as well as to the work of the International Labour Organisation, and he points out that the machinery of the League has been of the first importance because it has worked far more rapidly than the old diplomatic methods and because by the pressure of publicity it has thrust aside the obstruction of interested powers.

Shortly before the outbreak of war, the Bruce Committee on the Development of International Co-operation in Economic and Social Affairs proposed the consolidation of these activities under a new general committee of the League designed to be apart from political passions and preoccupations. Lord Cecil, however, insists on the necessity of direct action to preserve peace, to supplement these activities if the fabric of civilization is to be maintained. "The marked success of the League's non-contentious work followed by the recrudescence of European war, is glaring evidence of the mistake made by those who urged that the League could be made to work as a peace-keeping machine without its coercive powers."

Lord Cecil believes that the constitutional union of independent States inside the general framework of the League might help to make men realize that it is only by international co-operation that peace can be preserved. He insists, however, on the fundamental point that no machinery can do more than facilitate the action of the peoples, and unless they and their Governments really put the enforcement of the law and the maintenance of peace as the greatest of national interests, no confederation can compel them to do so. The League experiment failed because the Governments did not do this. Lord Cecil's indictment of the absence of far-sighted and courageous leadership is severe though restrained.

Lord Cecil's volume leaves the reader in no doubt as to the greatness of this experiment in conception and scope, if not in achievement. Whether it can be considered a scientific experiment is another question. None the less, this book,

with its calm appraisal and poise, as characteristic of the scientific spirit as of the judicial mind, which is Lord Cecil's by training, gives us at least a pointer to a scientific approach to the problem, the basis for further experiments on scientific lines in the future. No serious attempt at world co-operation and reorganization can afford to neglect the wisdom and experience gathered in the great experiment Lord Cecil so luminously describes.

Lord Cecil has placed us further in his debt by a pamphlet, "A Real Peace"*, addressed to a wider public, in which he attempts to apply this experience and these conclusions to the problems which will confront us in building a real peace in Europe when hostilities cease, and particularly to the central problem presented by Germany. The pamphlet is more than a reiteration of the conclusions elaborated in the final chapter of "A Great Experiment". He points once again, it is true, to deficiencies of leadership, to the ignorance and short-sightedness which brought the League to failure, and he emphasizes the central lesson that a breach of the peace anywhere is a danger to peace everywhere.

This pamphlet should assist in bringing this lesson home to all, but it is also far more specific. It indicates the importance of the German problem —the necessity of assuming that the peace-loving powers may have to deal with the menace of another German attempt to establish world tyranny by force, and that they must find some way to build up the forces of peace sufficiently to make aggression by Germany or any other power a hopeless proposition. He utters words of caution about the form of international authority which may be required, but considers that any organization for the preservation of peace in Europe should ultimately be open to any country the good faith of which can be trusted and which is prepared to enter into a definite undertaking to collaborate in that purpose with its whole strength.

The advocates of federation commonly place the responsibility for the failure of the League on national sovereignty. Robert Dell, for example, in "The Geneva Racket"†, urges that there is no chance of a permanent peace unless Europe is federated, and asserts his conviction that the abolition of absolute national sovereignty is the essential condition of any solution of the problem of peace. Such critics may well hold that Lord Cecil passes too lightly over the problem of sovereignty, but they must recognize the vital effect of a change in the spirit of the Governments, especially of the Great Powers, for which Lord Cecil contends. Without such a change and the sincere determination to use the League machinery for the purposes for which it was created, no League of Nations will work, however perfect its machinery.

The international authority, Lord Cecil considers, should be based on the representation of States, not of populations, though he would reinforce it by regional groupings ; federation is a matter rather for the future. He touches on the particular problems of minorities and of colonial possessions and mandates, on the necessity for further facilities for peaceful change, and on the three stages by which we must proceed from a state of war to one of established and ordered peace : first armistice, then a conference of belligerents of both sides to consider the actual issues raised by the war, and finally after a reasonable interval a full congress of all interested countries, neutral as well as belligerent, to decide all questions arising in a world settlement.

Lord Cecil does not claim, as Mr. Winant does for the International Labour Organisation, that the League is an instrument true and proved and adapted to our purpose. He does at least see in it an instrument which can be re-shaped, re-forged if need be, to give effective service, if only the spirit and will to use it for its high declared purpose are forthcoming. Progress towards an international society or true world federation may well proceed on two parallel lines : horizontally, through the gradual development of the League towards a federation by progressive limitations of the sovereignty of its members ; and vertically, by way of geographically limited groups or federations in the true sense of the word, established on the basis of affinity of culture, of language, of tradition and of political ideas. To both processes Lord Cecil makes a noble contribution. It is only by education, by creative thought and free discussion that there can come in fullness of time, the wisdom and understanding, the vision and determination which will build on that which remains to us of our heritage, a new League, preserving historic continuity, universality and the unity of the human race, fortified to overthrow all onslaughts of aggression ; and worthy of the sacrifices already incurred in the service of the principles of freedom, truth and justice which it enshrines.

* A Real Peace. By Viscount Cecil. Pp. v+34. (London: Hamish Hamilton, Ltd., 1941.) 6*d*. net.

† The Geneva Racket. By Robert Dell. Pp. 375. (London: Robert Hale, Ltd., 1941.) 18s. net.

PHYSICS AND THE FUTURE

FOR the majority of citizens science remains inaccessible. It has little or no place in their school life, their newspapers, their cinemas, their radio, or their literature. Although present-day civilization depends entirely on applied science, even the politicians and rulers, who guide our affairs, share this common unfamiliarity with science. Dramatic events like war, however, in which science is misapplied, forcibly direct attention to man's most powerful tool. If the War of 1914–18 was a chemists' war, the present affliction, with its extensive mechanization, radio propaganda and aeronautical developments is a physicists' war. Aerial bombardment alone might almost be called a nightmare of complex physical problems the solution of which would need the efforts of more than the whole of the country's physicists. In the circumstances, a scarcity of physicists is not surprising. The Board of Education is approaching the problem by offering a number of State bursaries chiefly in physics, engineering and chemistry (see p. 251).

But the dearth is world-wide. Of the 4,500 American physicists, about 1,400 are already engaged on war work and 600 more are needed within the next year. One hundred others are needed in essential production industries*. The present solution of letting some of the physicists desert the universities is hampering both the training of future physicists and the production of new physics.

If physicists were wanted in large numbers solely in war-time, and then only to assist in the slaughter of vast numbers of citizens of the world, there are many who would care little for the future of physics. But physics is of vital importance in war-time for the very reason that it will be of vital importance in the future peace. Until the biological sciences have developed, applied physics is man's most powerful tool in dealing with his environment. The fact that civilization is at present misapplying the tool means that, in peace-time, it must be used with redoubled energy both to make good the damage done and also to make up for the time lost during war.

What then are the difficulties in providing an adequate supply of physicists ? In the first place, physics, like all the sciences, is expensive to teach. In many schools the sciences are still apt to be regarded as 'extras' just as in daily life the sciences are outside most men's experience. Of all the sciences, physics is the most expensive. Cost is therefore a highly relevant factor. Money and methods of teaching must be found so that every boy and girl without exception is consciously brought into contact with physical phenomena. Physics will then suffer no neglect, as at present, from ignorance. But not all intelligent boys and girls are potential physicists. Special abilities as well as love of physical phenomena are needed. A mathematical mind, if not technical skill in mathematics, is essential to the physicist in order that he may benefit from the results of mathematical physicists and that he may be able to present his own theoretical problems in suitable form to mathematicians. Then again physics is difficult because it covers not one, but several subjects.

When potential physicists are found they have to be trained. More attention has been given to this process in the United States and in the U.S.S.R. than in Great Britain. Here, expense is again the most significant factor although its influence is subtle. University teaching of physics must be associated with research. But research apparatus is so expensive that little money can be spared for extra non-graduate research assistants and technicians. It is an open secret that a university professor of physics can get more easily the money to pay an extra graduate than a non-graduate member of staff. As a result, junior members of staff are in practice appointed not only for their research abilities but also because their type of research apparatus is already in the department. In a school of research they must in fact play the part of research assistants and technicians, incidentally making apparatus for part of the time which otherwise might be spent in making physics. It would indeed be fortunate if when each new appointment were made research ability and technical experience in a particular branch of physics were combined with equal ability in training physicists.

That no very serious attention is given to the method of training physicists is a result of the comparatively short time of establishment of most physics laboratories. Two other factors are relevant. The reputation of a university physics department as a source of physicists depends upon those few students who, taking to physics as ducks take to water, are almost if not quite independent of the method of training. Then again, until comparatively recently, but few physicists have been used in industry. Conditions have now changed. Physicists whose main task in life is rather to apply than to make physics are, and will continue to be, wanted in increasing numbers. If

* Rev. Sci. Inst., 12, 177–78 and 247–49 (1941).

serious consideration were given to their training, no harm would be done to the few born physicists and much help might be given to the production of physicists who would go out into the world and apply physics to man's needs.

Before the War, the average cost of a university research paper in physics was not less than £300. The average cost of the equipment needed to start work in any one of the specialized branches of the subject was £1,000. An expenditure of £15,000,000 a day on equipment for warfare may make the expense of physics seem paltry. Sufficient evidence of poverty-stricken conditions of some physics research can be seen in such papers as appear from time to time in the *Journal of Scientific Instruments*, where research is described on finding an inexpensive way of carrying out some physical operation for which ready-made but more expensive equipment is already available.

If physicists' contributions to war help to remove ignorance of physics, the money needed for physics in peace-time may be forthcoming. Then will be the time to show that applied physics is as powerful a tool for construction as it is at present for destruction or protection. Even if a university graduate in physics has paid for his training from private sources he will still have cost the community large sums of money. By using his talents together with his training he can repay in service to mankind. Tremendous possibilities lie ahead. One only need be mentioned. At present biology is absent from the education of most men, including physicists. Officially, the physicist knows nothing of life. When this blind spot has been removed, some physicists will feel drawn to biological problems and the wonderful developments of biochemistry will be matched by those of biophysics.

The excellent equipment of the physicists in the United States and the U.S.S.R. should be a lesson not yet appreciated in Great Britain, that, generally speaking, the day of physics done with sealing wax and tobacco tins is past. Physics is an expensive subject and will become more so as each new development is made and applied to revitalize older branches of the subject. But in return for the cost, physicists can and will repay in service to mankind by making and applying physics and by helping to train the next generation. To help recovery from the tragedy of war every scrap of brain-power will be needed. Given the means, physicists can and will play a vital part in this recovery.

IS MARXISM SCIENCE?

Marxism : Is it Science? By Max Eastman. Pp. 343. (London: George Allen and Unwin, Ltd., 1941.) 8*s*. 6*d* net.

MAX EASTMAN is a somewhat odd critic of Marxism. He appears to accept at the outset most of the aspects of Marxism that have made it anathema to orthodox opinion. Not only does he agree with the economic analysis Marx made of the capitalist system, but even with the revolutionary application of this analysis by Lenin. But this seeming agreement covers a fundamental objection to the whole method of Marxism. He is an inveterate opponent of dialectical materialism, not because of its results, but because it represents a type of thinking profoundly different from his own. Max Eastman is a perfect type of nineteenth-century intellectual radical, a believer in common sense and engineering, with a violent antipathy to all forms of philosophy and religion. The book itself represents only one stage in retrogression towards older views. Since it was written, Max Eastman, from being a critic of Marxist logic and philosophy, has moved to a rejection of Marxist economic theory and political ideas.

In this book his fundamental objection to Marxism is that it is religious. Religion he defines as the belief "that the external world, or some power in it, is interested in the interests of men. The religious believer persuades himself that the world is softer than it is, and that we know more about it than we do". And Marxists are religious because "they cherish a belief that the external universe is evolving with reliable, if not divine, necessity, in exactly the direction they want it to go". What he would like instead is a stern belief in the indifference of the world, and what he calls the "engineering approach" to social problems.

"An engineer wishing to convert a given form of society into a more satisfactory one, would begin by making a very rough outline of the kind of society he proposed to build. With that rough blueprint in mind he would examine the existing society, and he would also examine all past societies, and find out what are the forces which control them and the general laws of their change. When he had finished that investigation and acquired that knowledge, he would draw up a procedure or plan of action, a scheme for getting the thing moving (supposing that his investigations had proven it possible) in the direction of his proposal."

The chief sin of Marxism in his eyes is neither its analysis nor its plan of action, but the fact that it mixes analysis with action, instead of keeping them rigidly separate. To prove his thesis he examines the historical origins of Marxism, with particular emphasis on the part played by Hegelian philosophy. Philosophy is naturally to him as destructive as, and far more insidious than, religion. Philosophy to him is a characteristically German rather than Anglo-Saxon way of thinking and acting, and the proof that Marxism is saturated with philosophy is enough to damn it.

There is no doubt that this line of argument will prove highly popular with men of science of the old school. They may be a little shocked by Max Eastman's advocacy of revolution, but will be comforted by the reflection that anti-Marxist revolutionaries are rarely dangerous to the established order and that Max Eastman himself has for years been a most usefully ally to Red baiters.

To anyone who has taken part in the revaluations of science that have been going on during the last twenty years this book will appear simply as a belated landmark of an earlier mode of thought, for the arguments advanced in it are based on a conception of science that has already long been felt to be insufficient—"knowledge derived by the methods of observation, experiment and rational calculation and subject to the practical test of action". This definition, like Euclidian geometry, is true only if we concern ourselves with some small portion of knowledge and action. It is, and will long remain, the working scheme for detailed scientific research ; but if we are concerned with the whole of human experience, its inadequacy becomes manifest. Separate studies, however accurate, do not of themselves provide an integrated picture, and the observer can no longer be kept rigidly separate from the thing observed. This is particularly so in the field of human affairs, where the application of classical science has singularly failed to produce any useful results. Indeed, if we accepted Mr. Eastman's criticism, Marx would be an even greater figure than he was, because he was able to arrive at correct results by using entirely wrong methods.

The aspects that Max Eastman rejects are those which have attracted so many modern men of science to the study of Marxism. In the development of human societies radically new events are continually happening which are not seen, or are seen only with difficulty, in the far slower evolution of cosmic or biological systems. The most striking changes do not appear to be due to any external causes. In human affairs, the problem of the origin of novelty is a central point of interest. Men of science, however, have been content for the most part to ignore all novel features. Some qualify the rejection of their study on the grounds that they lie outside science and in the province of history, where the scientific method was not applicable. Others, without realizing it, evade the issue by appealing to some efficient cause, some life force, which, acting from the outside, brought the changes about. This is a mere deification of ignorance. If these changes are to be tackled scientifically, their origin must be looked for inside the system, in the interaction of its parts. It is this interaction which Marx, using Hegel's terminology, conceived of as a conflict of opposites leading towards a resolution into some new State. The fact that Hegel's opposites referred to a world of pure thought is no more refutation of his system than the fact that Newton's was derived from theology. Both were trying to set down in a language they found appropriate the new relations they had discovered. Marx's opposites, capital and labour, were real enough and engaged in real enough conflict. But if this kind of development by internal conflict could happen in rapidly changing civilized societies, it was very likely that it was happening less rapidly elsewhere ; and, by generalizing the theory of dialectical materialism, Marx and Engels, and particularly the latter, were able to indicate that other conflicts probably underlay earlier changes in human and animal life, and farther back at all critical points of cosmic history.

Critics have objected to dialectical materialism on the grounds that it does not prove anything. But Marx was aware of this, and indeed stated it explicitly. Dialectical materialism aims, not at proving things, but at discovering them. Whether or not it is scientific is an academic question, and depends on whether the word science is to be conceived of narrowly as physical science, or is to include an orderly treatment of the whole range from nebulæ to human society.

The contrast between the old and the new ways of looking at things is most clearly seen in relation to human psychology. One of Max Eastman's major objections to Marxism is its rejection of psychology in the individual sense and the statement that a human being is an ensemble of social relations. Now this central insistence on a human individual is itself a relic of Darwinian controversy, and carries farther back to Descartes's division of body and soul . . . indeed, by neglecting the social aspect, nineteenth-century men of science practically forced the acceptance of a duality between a merely animal body and an æsthetic and moral mind. Marx always rejected this view, and now the modern anthropologists are showing more and more clearly that the uniqueness of man lies not in any of his bodily or mental characteristics as such, but in the fact that he forms part of

a self-perpetuating, self-conditioning community. The centre of interest in Marxism is this community and its development. Human environment is no longer, like animal environment, mainly physico-chemical or biological; it is social: and a social environment is not indifferent to the individuals composing it. If society changes it will always be ultimately because of the desires of the individuals composing it; but it will only be in the general direction of those desires if the individuals who are making the change understand the mechanisms by which change can be brought about. The value of Marxism is precisely the statement of this fact. Any attempt to apply engineering methods to human society, as Max Eastman would like to do, is necessarily to ignore the fact that the very desires of the engineer are conditioned. In so far as he is not aware of this, his aims will themselves be merely a reflection of the crudest aspirations of contemporary society. Indeed, this attitude actually leads straight to Hitlerism. "Mein Kampf" is the perfect illustration of an extremely astute social engineer at work, conscious of his end, conscious of his method, but unconscious of what conditioned his choice of end, or of the probable results of his action in destroying all the things he set out to reach.

The practical burden of Marxism is that effective choice of ends cannot be made without understanding the trends and conflicts of the existing situation. "Freedom is the recognition of necessity." But this does not make Marx a fatalist. When Lenin pointed out that socialism would not occur unless a party worked consciously for its realization, he was closer to Marx's intention than Plekhanov, who believed that it should be left to the automatic working of economic forces.

Marxists say that our actions and our knowledge are never separate, and that we would do well to realize the fact and consciously to combine them. If we imagine that they are separate, we will not only fail to be scientific, but will doom ourselves to a tragic futility.

J. D. BERNAL.

THE STATE OF PHYSIOLOGY

Annual Review of Physiology
James Murray Luck, Editor; Victor E. Hall, Associate Editor. Vol. 3. (Published by the American Physiological Society and Annual Reviews, Inc.) Pp. viii+784. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1941.) 5 dollars.

THE subject of physiology may be likened to a State at the frontiers of which lie several other sovereign States, with which it is in friendly relationship. It is a State consisting of several provinces, and while those inhabiting each province speak the language and appreciate the outlook of those across the frontier, they may be relatively ignorant of the language and customs of those who inhabit other provinces of their own State.

Here, surely, is ripe material for infiltration, with a view to conquest, by neighbouring States, for the liberation of oppressed minorities, and so on. There have, indeed, been Trojan horses (of the friendliest kind)—now it is organic chemistry that holds the key to the mystery of life—or now biophysics—that word to conjure with, that is to be the secret weapon against which none can prevail—or now all riddles dissolve before the heat and light of physical chemistry.

Yet the complex little State carries on, preserving its individuality and its ideals, in spite of all. It is enabled to do this because it has, in reviews of the kind now before us, a sort of parliamentary clearing-house—a talking-house if you wish—where those representing the subjects of its many branches can show what they stand for, and what they have achieved during the period under review. Thus some common understanding and cohesion is maintained and mutual regard kept alive between the different departments of a constantly growing endeavour. It is a pleasure to know that this service to science, which in the old days of international sanity was largely performed by publications in the German language, is, and for some years has to an increasing extent been carried forward in the English tongue, and very largely by American effort.

The present volume, considerably larger than its two predecessors, maintains the high standard of usefulness that was set by them. The contributors are all of high repute, and the outlook of the work is international, in so far as present circumstances allow.

An essential, and perhaps the most important part, of the work is the bibliographies appended to each of the articles. These represent a reasonably full list of the chief publications dealing with the subject of the article; sometimes the list runs into hundreds, and is rarely less than one hundred. The text of the articles is of the nature of a running commentary on the references. The indices of names and subjects, as is usual with American publications, are compiled with care and skill,

As regards the articles themselves, it is obviously not possible to review these adequately. The following bare list of the contents, however, will show that there can be few who are interested in any of the branches of physiology who could fail to find an article that appealed to them :

The relation of bioelectric potentials to cell functioning (G. H. Bishop); the physiological effects of radiant energy (H. Laurens); physiological aspects of genetics (A. H. Sturtevant); developmental physiology (E. Witschi); growth (C. E. Palmer and A. Ciocco); temperature regulation (J. C. Scott and H. C. Bazett); energy metabolism (T. M. Carpenter); respiration (C. F. Schmidt and J. H. Comroe, jun.); physical properties of protoplasm (E. F. Adolph); muscle (W. O. Fenn); the digestive system (J. E. Thomas); liver and bile (W. B. Hawkins); formed elements of the blood (G. M. Higgins); heart (C. J. Wiggers and H. D. Green); peripheral circulation (V. E. Hall); electrical activity of the brain (H. H. Jasper); the autonomic nervous system (D. Sheehan); the special senses, (1) hearing (E. Barany), (2) visual receptors (R. Granit), (3) vibratory sensations and pain (Y. Zotterman); physiological psychology (H. S. Liddell); kidney (L. Leiter); metabolic functions of the endocrine glands (S. Soskin); endocrine aspects of the physiology of reproduction (O. Riddle); reproduction of mammals (M. H. Friedman); bacterial chemotherapy (E. K. Marshall, Jr.); histamine and anaphylaxis (W. Feldberg); exercise (A. H. Steinhaus).

The paper is matt and restful, and the type and make-up of the best.

C. Lovatt Evans.

MOLECULAR SPECTRA

The Identification of Molecular Spectra

By Dr. R. W. B. Pearse and Dr. A. G. Gaydon. Pp. viii+221+8 plates. (London: Chapman and Hall, Ltd., 1941.) 42*s*. net.

To identify a given system of bands in molecular spectroscopy, "it has hitherto remained necessary to search through original papers or to calculate the positions of bands from the tables of derived constants. . . . This task is usually tedious and sometimes impossible to one without considerable experience". Drs. Pearse and Gaydon have compiled tables of data which will facilitate the identification of bands occurring in the region 10000 A. to 2000 A. The data, in tabular form, include the recorded systems of diatomic molecules and a certain amount of data on polyatomic molecules; in many instances the authors have extended recorded data by actual measurements. Data on complex organic molecules and on solutions have not been included, but that in no way detracts from the value of the book since it must be obvious that such a compilation must be limited by two main factors, (*a*) a defined wave-length region, and (*b*) an enforced limitation of the molecular types to be included.

Essentially the work contains two sections, and their contents can be conveyed most conveniently in the concise statements relating to them in the authors' introduction: "The first section consists of a list of the strongest heads of the more persistent and better known band systems of each molecule in order of wave-length, together with information as to origin, intensity in various sources, and appearance. The second section consists of individual lists of band heads for each system of each molecule, accompanied by notes about the occurrence and appearance of the system, the nature of the electronic transition involved, the vibrational assignment of the bands in the system, and references to the sources of the data. The lists are arranged in alphabetical order of the chemical symbols of the molecules."

The arrangement of the tables is exceptionally clear; band heads are listed in groups of five with a space between each group, which makes their perusal less trying than if they had been printed close on each other line after line. In the second section the appearance and occurrence of each band are described in a crisp and complete manner. Thus the book is lifted from being a mere collection of data. The quoted references to original papers have been selected with care and discrimination. That the book has been compiled from the practical point of view is borne out by an excellent short account (10 pp.) of various points, troublesome to the inexperienced, arising in identification and "not usually dealt with in general text-books"; these "practical hints" are an extremely useful feature, as is also the inclusion of fifty selected—and exceptionally well-reproduced—spectrograms.

The authors have accomplished the tiresome work of collection, selection, compilation and arrangement of the vast amount of data with clarity and skill, and the publishers and printers have done their jobs with equal acceptance. Such a book is needed by workers in this field, and the volume under review can be thoroughly recommended.

W. Rogie Angus.

Chemical Computations and Errors

By Prof. Thomas B. Crumpler and Prof. John H. Yoe. Pp. xiv+247. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 18*s*. net.

THE authors state that their aim in writing this book has been to provide a course on chemical computations and errors for university students specializing in chemistry, and this they appear to have done extremely well. The subject-matter is clear, concise and well arranged, and the reviewer considers that several chapters of the book are admirably suited to the use of sixth-form pupils.

The first five chapters of the book give a simple account of exponential numbers, logarithms, the slide rule, algebraic equations, including the solution of simultaneous equations by determinants, graphical interpolation and extrapolation. The inclusion of historical details in these chapters, and indeed throughout the book, is a very pleasing feature. The chapters on the "Theory of Measurement" and the "Classification of Errors" should be most helpful to the student who takes a serious interest in his quantitative practical work, and he will understand, perhaps for the first time, why there is a difference between a cubic centimetre and a millelitre. A very clear distinction is made between "corrigible errors", that is, those errors for which corrections can be made, and "random errors" for which it is impossible to do anything.

The remainder of the book is mainly concerned with that branch of statistics which deals with the interpretations of discordances in numerical values. Chemistry students will be particularly interested in the statistical treatment of Lord Rayleigh's measurements of the density of nitrogen (pp. 186–188), where it is shown that the actual difference between the mean values for chemical nitrogen and atmospheric nitrogen is 34 times the probable error. This figure, the test shows, provides conclusive statistical evidence for believing that the composition of the two specimens of nitrogen is different.

Suitable problems are set at the end of each chapter and the answers, together with logarithm tables and a useful bibliography, are given at the end of the book.

Elements of Botanical Microtechnique

By Prof. John E. Sass. (McGraw-Hill Publications in the Botanical Sciences.) Pp. ix+222. (New York and London: McGraw-Hill Book Co. Inc., 1940.) 17*s*. 6*d*.

THIS book is the latest addition to the McGraw-Hill series of texts in plant science, which is being steadily built up into an encyclopædia of specialist monographs such as botanists have never before had available. As it follows rather closely on the appearance in the same series of Johannsen's treatise on the same subject, one may first ask what, in the circumstances, is the justification for its publication.

It is neither so comprehensive nor so detailed as the previous work, yet there can be no doubt that it has qualities which earn for it a just title to independence. In the first place it is more genuinely a students' book than Johannsen. It assumes very little preliminary knowledge, and it gets down to fundamentals with commendable practicality. Moreover, its outlook throughout is thoroughly modern and is indicative of that revolution which the commercial production of new organic solvents and plasticizers is rapidly bringing about in the field of microscopy. Old difficulties are vanishing as we begin to know how to build rationally on the empirical foundations laid by the pioneers. Not that we have got far, as yet, and one can foresee that future editions of this book will show many changes as new methods are developed.

One should note with satisfaction the passing away of the period of uncritical microtome worship and commend the sane advice given on when not to microtome. Smear methods, whole-mount methods, maceration (too long neglected), the critical comparison of fixatives: all these are welcome features, even if they are not exactly innovations. The emphasis and the clear illustration given to them in a book for students are certainly novel.

It is refreshing also to see not infrequent comments on expense in an American publication. Is this indicative of another break with tradition ?

R. C. McL.

Dietetics Simplified: the Use of Foods in Health and Disease

By Prof. L. Jean Bogert. With Laboratory section by Mame T. Porter. Second edition. Pp. xi+742. (New York: The Macmillan Company, 1940.) 12*s*. 6*d*. net.

DIETETICS as a subject is peculiar in that its exact study requires elaborate detail and specialized knowledge whereas in practical application no such desiderata are necessary. This at once explains the difficulty of writing a book which should be of service to those who do not need over-much technical knowledge yet are at the same time expected to understand the principles and their employment in everyday life. Students of medicine and domestic science, hospital dietitians, nurses, etc., all need education and help.

Prof. Bogert has tried to plan "Dietetics Simplified" to meet this requirement. That she achieves her aim is shown by the appearance of a second edition three years after the first. She has not, however, felt called on to make extensive alterations but only to bring the data on special points, such as vitamins and food values, up to date.

The scope of the book is planned on generous lines. Elementary nutrition, diet in normal conditions, diet therapy and diet in disease states are supplemented by a series of chapters on cookery of every kind and by careful tables on nutrition figures. The sections on infant feeding and food for the elderly may be remarked on as illustrative of the standard set and attained.

The book is written in an easy attractive style, free from undue technicalities and well illustrated. It can certainly be commended.

MILK PRODUCTION IN WAR-TIME

By Prof. H. D. Kay, O.B.E.
National Institute for Research in Dairying

If from the point of view of human nutrition in war-time the gravest problem is that of providing sufficient calories, the next in importance is undoubtedly that of maintaining at the highest possible level the daily inflow into the national larder of milk—with its unquestioned value in balancing and reinforcing, either for the young or the adult, a diet which may be short of calcium, vitamin A, riboflavin, animal protein, and fat. The adequate solution of the milk problem is dependent on many factors, agricultural, economic, administrative, etc. It is proposed to discuss a few of those in the first of these categories, mainly concerned with feeding and management of the dairy cow in war-time.

It is believed that of all farm animals, the modern dairy cow is the most efficient converter of farm feeding stuffs into human food. This, however, is true only for the animal of medium or higher yield, say, for present purposes, for the animal yielding not less than 500–600 gallons per lactation. It is again fortunate that, as a ruminant and by preference almost entirely a herbivore, the cow, unlike the pig and the hen, does not seriously compete directly with man for the kind of foodstuff he requires for his own diet. In the third place it is fortunate also that as a result of past research, a great deal is now known about the detailed nutritional needs of this highly specialized animal for efficient lactation, though this knowledge, particularly valuable in war-time, is effectively applied on far too small a proportion of our dairy farms.

Quantitatively, the dimensions of the problem of feeding the cow are greater in this than in the War of 1914–18. The dairy cow population at the outbreak of the present War was more than 20 per cent above that of 1914, and there has, if anything, been an upward trend in the last two years. In tonnage, the amount of food required for the dairy herd is not far short of that needed for the entire human population. The average dairy cow weighs about half a ton, and although she will provide each year say 500–600 gallons of milk, containing a dry weight of some 6 cwt. (that is, nearly twice her own dry weight) of first-class human food, she must have, if she is to remain a productive unit, not far short of four tons a year of foodstuff, estimated as dry matter. When this requirement is multiplied by well over three million (the exact number of 'dairy' cows depends on a rather arbitrary definition as between a 'dairy' cow and a 'beef' cow), the huge size of the problem—that of providing some twelve million tons (dry weight) of feeding stuff per annum to secure adequate milk production—is apparent.

It is not generally realized that as much as 80–85 per cent of the total food consumed by the dairy cow (estimated, of course, on a dry-matter basis) is, in peace-time, produced at home, from grazing and from other farm-produced foodstuffs such as hay, straw, roots, kale, silage, etc., these latter for the most part bulky foods with a relatively low energy and protein content and containing a large proportion of indigestible fibre.

For present purposes we may regard the essential food requirements for efficient lactation in the dairy cow as being a sufficiency of digestible nutrients in a bulk which does not exceed the assimilatory capacity of the animal. These nutrients have to provide (*a*) the animal's basal metabolic needs for energy, (*b*) her energy requirements for purposes of muscular movement, digestion and glandular activity, including the activity of the mammary gland and the relatively small amount of material necessary for the day-to-day repair of these tissues, and (*c*) the materials needed for the synthesis of the very considerable quantities of lactose, casein and lactalbumin, and fat secreted by the udder*. The war-time significance of this statement is that the food materials required for (*c*) are rather different in composition than those needed for (*a*) and (*b*). They are richer in protein, and belong mainly to the type of concentrates that was extensively imported from abroad in peace-time.

To obtain the necessary nutrients under (*a*), (*b*) and (*c*) from the ordinary, bulky farm foods is only possible if the yield of milk is small, say ½–1 gallon a day. The capacity and appetite of a high-yielding dairy cow do not allow her to eat sufficient of such bulky foods to maintain her milk yield for very long. She is, like nearly all modern farm animals, in a state of unstable biological equilibrium. Without adequate feeding of concentrated foods she may for a short time continue to secrete large amounts of milk at the expense of her own tissues, but this process will not continue and she will eventually rapidly fall off in yield.

The main problem of feeding for milk production

* The nutrients have also to provide, in most cases, for the growth of the fœtal calf. The main demand here, however, is late in lactation when the milk yield is falling off.

in war-time is to provide the type of concentrated protein-rich nutrients required for purpose (*c*), and that despite the facts that importation of concentrates from abroad is severely cut down, that the by-products of flour milling will soon be both less in quantity and in nutritive value since 85 per cent instead of 73 per cent of the wheat grain will go into flour for human consumption, that there is a shortage of skilled labour on the farm, and that a larger area of farm land is now being used for the production of human foodstuffs such as wheat and potatoes, the by-products of which are not very useful for purpose (*c*).

Without concentrated feeding stuffs, especially in winter, and adequate husbandry the dairy cow would fairly soon revert to a low-yielding animal producing most of her small output of milk from grass in the spring and summer months, and drying off completely in the winter. But alike with the good and the poor cow, feeding presents no problem at all if grass, which if of good quality will contain all the protein needed for purpose (*c*), is abundant. Up to four or even five gallons of milk a day can be produced without difficulty or damage to the cow, and without any supplementary feeding of concentrates, if such grass is available, and fields are grazed in rotation under reasonably efficient conditions of grassland management. In most parts of Great Britain, however, an abundant supply of grass rarely persists for more than three or four or possibly five months of the twelve. For the remaining months both bulky farm foods and concentrates containing sufficient protein are essential, in addition to what the cow can pick up from the pastures, if an average, or better than average, yield of milk is to be maintained. It is particularly in December, January and February, when natural environmental and war-time nutritional conditions both for the dairy cow and for man are at their worst, that human needs for a protective food like milk are at their greatest.

It has been suggested that the nationally most satisfactory war-time plan is for the dairy farmer to go in for summer milk production from grass, and winter his cows in a practically non-lactating condition. The large excess of milk not required for human nutrition during the summer months would then, it is suggested, be dried or "evaporated" and stored, for distribution during the winter season instead of liquid milk.

Even if the requirements of only three winter months were to be met, this scheme would entail treatment of some 240 million gallons of milk, that is, a large increase in our existing milk-drying and evaporating capacity (with plants very busy during the summer and idle during the winter), a very large supply of tin plate or other material suitable for making containers to store the 130,000 tons or more of processed milk, probably an organization to reconstitute the milk in numerous depots, and certainly a formidable change in food habits. Though milk dried or "evaporated" by modern methods and properly packed for storage loses very little of its nutritive value, it is very doubtful indeed whether any extensive change over to summer milk production is either feasible in war-time or advisable at any time.

In present circumstances, the only means by which milk yield may be maintained in winter are: (1) the switching over to the dairy cow of sufficient concentrated feeding stuffs, both those produced at home and those that continue to be imported, from less essential stock such as pigs and poultry, or (2) an increase in quantity and quality of the feeding stuffs grown on dairy farms at home, so that they not only provide all the maintenance rations needed for purposes (*a*) and (*b*) mentioned above, but also meet the higher protein requirements for purpose (*c*).

Alternative (1) is the foundation of the rationing system that was introduced half-way through the winter of 1940–41. By this system the greater proportion of the available concentrates were allocated to dairy cows: farm horses and one or two other categories of essential animals received a sufficient ration, beef cattle were reduced to about 50 per cent of their pre-war requirements, and the small amount left was allocated to pigs and poultry. Alternative (2) is clearly one which needs time to achieve. It means in the first place the improvement in quantity and quality of the grass produced on the farm, an improvement which had in fact begun, if only in a small way, before the War. This entails the ploughing up, appropriate artificial manuring, and re-seeding of worn-out or indifferent pasture, the general improvement of grassland by adequate dressings of lime and phosphates, the use of suitable seed mixtures and nitrogenous fertilizers on selected fields to produce grass one or two weeks earlier in the season and possibly to induce grass to linger for about the same length of time in the late autumn, with a corresponding economy in concentrates. It also means the making of silage in the spring from young grass (the younger the grass the higher the protein content) and particularly in the autumn from aftermath, or from special mixtures of cereals and pulses which have a high protein content, improvement in methods of haymaking, to ensure that losses of feeding value are minimal, the use of green 'soiling crops' such as mixtures of pulses and cereals, or, in warm districts, maize, to supplement the grass supply during the summer and early autumn, the growing of more cabbage and kale to provide green fodder

during the winter months, an additional acreage of peas and beans to provide protein-rich fodder, an increased production of root crops such as swedes and mangolds for winter and early spring feeding, the production of a valuable food, of approximately the same energy value for the ruminant as good hay, from wheat straw (a material not normally used for feeding dairy stock, but which is increased in amount over pre-war quantities) by soaking it with dilute caustic soda solution, the intelligent use both of farmyard and artificial manures. These are all aspects of good dairy farming by which dependence on purchased feeding stuffs will be steadily lessened during the present year and in the future. Many dairy farmers, after the 1941 harvest, will already have achieved this objective of self-support, and the rationing scheme for dairy cows for this winter will undoubtedly be largely based on this fact.

Little has been said about the effect of war-time conditions on milk quality. In general, quality is rather more stable to environmental changes than is yield. If yield falls, then there is normally a small increase in milk fat percentage, as was in fact observed last winter. Insufficient feeding of concentrates, in addition to its depressing effect on yield, is sometimes associated with a diminution in the percentage, of solids other than fat in the milk. On the whole, however, it may be said that the war-time diet of the milking cow will only have quite small effects on the composition of her milk.

Second only in its effects on milk yield to a shortage of feeding stuffs, and much more drastic in its effects in reducing the nutritional quality of milk than any other factor, is udder disease. Even in the sub-clinical stages mastitis produces a marked fall in the compositional quality, and therefore in the nutritional value of milk, together with an appreciable drop in total quantity secreted, and the changes become more serious as the disease progresses.

In peace or in war, until this disease—or group of diseases—is taken in hand on the national scale, these largely avoidable losses will continue to be suffered. Some authorities are of opinion that there has been an increase in udder disease during the last two or three years. This may well be, as with the unskilled labour that has on many farms replaced the pre-war skilled cowman—a process which began before the outbreak of war—early symptoms of the disease are easily overlooked and veterinary treatment delayed until irreparable damage has been done to the udder tissues. An animal even at this stage may continue to secrete a little poor quality milk without requiring supplementary concentrates in her diet, but since the food required for maintenance of a poor or indifferent animal is little if any less than that required for maintenance of a high-yielding cow, the former animal is wasting food if the criterion of milk yield divided by total food consumption is applied. At the other extreme, the very high yielder in war-time is difficult to handle successfully, as she requires highly skilled management and in some cases special foodstuffs, neither of which may be available. The desirable dairy cow in war-time is an animal giving a good, but not an immense yield.

In war-time as in peace-time, culling of the inferior yielder pays. It is possible to cull without losing milk at all if the foodstuff virtually wasted on the poor yielder is distributed among the better yielders, and—an important proviso in war-time—if rations of concentrates are provided on a basis of milk produced and not on a basis of numbers of cows. Even in war-time, a scheme for the control and treatment of mastitis, associated with a culling policy for getting rid of incurable chronic cases, would be greatly beneficial to the national milk supply.

The fall in milk-yield that was evident in the winter of 1940–41 was probably as much the result of climatic conditions highly adverse to milk production as to local shortages of feeding stuffs. The uncertain climatic factor renders any prediction as to the probable total milk yield during the mid-winter months of 1941–42 very hazardous. The yield in the winter of 1940–41 was some 7 per cent below that of 1939–40, which was itself only about 2 per cent below that of the winter of 1938–39, a winter of record output. Will this fall become greater in the most critical months of 1941–42? There are good reasons for hoping that it may not. Under next winter's rationing scheme, with absolute priority for the dairy cow in supplies of concentrates, and with the strenuous efforts that many dairy farmers have been making during the past twelve months to make their farms more nearly self-supporting as regards feeding stuffs for milk production and not merely for maintenance, the dairy cow should be adequately, though not generously, provided for during the forthcoming winter. Though culling of poor yielders is being officially encouraged, the national herd has not diminished. The hay crop, on which much depends, has been on the whole a fair one, with hay of good quality. Grass has been plentiful in most parts of the country, which means that the reserves of feeding stuffs for summer use have not as yet been consumed. The loss of milling by-products resulting from the increased rate of extraction of flour from wheat should be more than offset by the increased production of oats and mixed corn during the present harvest.

The labour situation is unlikely to become more

serious, as experienced male agricultural workers are not being called up, and more Women's Land Army recruits are being trained for work on dairy farms. The present very high prices paid for dairy cows indicates that even if certain farmers are turning over from milk production to other less-exacting types of farming that appear to be giving, for the present at least, equally good returns, their dairy animals will not be lost from the national herd. What is less certain is whether the slight trend towards summer milk production shown during the past twelve months will be accentuated. If autumn calvings are markedly fewer in 1941 than in 1940, then there will be an increased shortage of liquid milk during the critical mid-winter months. If they are not, the winter milk yield of 1940–41 is very likely to be maintained during the forthcoming winter.

THE "HOROLOGIUM OSCILLATORIUM" OF CHRISTIAN HUYGENS

By A. E. Bell

St. Marylebone Grammar School, London

THREE great works laid the foundation of modern mechanics: Galilei's "Discourses on Two New Sciences" (1638), Huygens's "Horologium Oscillatorium" (1673), and Newton's "Philosophiæ Naturalis Principia Mathematica" (1687). Of these, the second is certainly the least well known, and least accessible to the English reader[1]. Yet it is more rigorous in the treatment of its subject-matter, more strictly mathematical in style than the others, and it certainly deserves more recognition than has ever been conceded to it. From Huygens's original intention to publish a work on the construction and scientific principles of his pendulum clock (employing a cycloidal pendulum), the work grew and grew over a period of about fifteen years, and finally issued forth in 1673 with much accumulated around its central theme. Unlike most of Huygens's other writings, the work is singularly free from all Cartesian influences. Huygens himself hoped that it would be in direct line with the great work of Galilei, and his hopes were not disappointed. Newton wrote to Oldenburg, the indefatigable secretary of the Royal Society, of his "great satisfaction" with the work, and said he found it "full of very subtile and usefull speculations very worthy of ye Author". Newton especially admired Huygens's mathematical style, and considered him "the most elegant writer of modern times".

Part 1 of the "Horologium Oscillatorium", "Containing a Description of the Clock", describes in detail how the various wheels and pinions of the mechanism are put together. The description is of great interest to the student of the history of clocks because in all except one particular Huygens's clock was based on the old balance clocks dating back to the thirteenth century. This particular was, of course, the pendulum, the adaptation of which (setting aside the slight claims of Galilei) was first successfully worked out in 1656; with small differences the pendulum was used in the same way in 1673, except that Huygens had in the interval discovered (1658–59) that the cycloid is the tautochrone and that consequently a cycloidal pendulum is isochronous for arcs of all magnitudes. To make the pendulum bob execute the correct curve the flexible part of the suspension hung between metal plates or 'cheeks', themselves later found to require the cycloidal form (see below). Huygens owed much indirectly to Pascal and Wren for his discovery of the tautochrone. "I am sure that geometers will value this refinement infinitely more than all the rest of my mechanical inventions", he wrote of the cycloidal pendulum. About the same time as he made this discovery, he started on theoretical researches which led to the first general solution of the problem of determining the centre of oscillation of a compound pendulum. In Part 1 the only reference to this, however, is a purely practical one: the clock could be adjusted to measure the mean solar day by moving a rider on the pendulum rod on either side of its middle position.

Huygens hoped much from the use of his pendulum clock, suitably suspended, to determine longitudes at sea. The matter is discussed optimistically in Part 1, but no dependable results were ever obtained with regularity on the various trials carried out during his lifetime. Bifilar pendulums and many others all proved unsuitable. Huygens invented a spiral spring regulator in 1665, and brought out a clock employing this ten years later. Clearly, it was only the lack of the necessary workmanship which stood between this principle and a successful chronometer. The spiral spring regulator does not enter the pages of the "Horologium", however, and this is accordingly a digression. Huygens, in fact, put his faith in the cycloidal pendulum clock equipped with a *remontoire* for greater exactness. Such clocks he con-

sidered were shown to be extremely accurate by his discovery that when two of them were in any sort of mechanical contact their pendulums (through a principle of resonance) beat perpetually together. The astronomers were impressed, and took up the clocks, but not the mariners. Hooke was a great opponent. "Sea-men knew their way already to any *Port* . . ." he naively remarked.

Part 2 of the "Horologium Oscillatorium" is entitled "On the Fall of Heavy Bodies and their Oscillation in a Cycloid". It begins with a résumé of the law of constant acceleration under gravity, and the treatment of forces as vector quantities. Among the well-known deductions obtained by Galilei and restated by Huygens, the latter gave the statement that the speed acquired during free fall from a given height will, under suitable conditions, enable a body to re-ascend to the same height (Prop. 4). Propositions dealing with descent over one or more inclined planes then follow. There is nothing here to add to Galilei's conclusions: the latter's work is merely systematized (Props. 5 to 9). In such an oscillation as that mentioned in Proposition 4, Huygens showed that the speed of a body is unique for any given height —a conclusion which in effect he traced to the change in potential energy (Prop. 10).

A good deal of arid geometry lies at this stage between the reader and the conclusion of the work. The extension of Galilei's work to cover descent over curves, combined with Cavalieri's method of exhaustions in the quadrature of these curves is of considerable historical interest, however. The work is too intricate to explain without a series of diagrams, but the principles may be indicated. Huygens first obtained limits to the length of a circular arc less than a semicircle in terms of tangential elements (Prop. 20). By reference to the generating circle this enabled him to evaluate the length of a cycloid arc in a similar manner, and to set limits to the time of descent over such an arc as compared with the time of descent over a tangent of equal vertical height and drawn to the highest point on the curve (Props. 23 and 24). By making use of the fact that a tangent to a cycloid is parallel to a corresponding chord on the generating circle (Prop. 15), Huygens was able to relate the time of descent over any cycloid arc to the lowest point with the time of descent over a chord of the circle (Prop. 25). Thus, his proof rested for its final step on Galilei's work.

Huygens did not include in the "Horologium" his proof that in a cycloidal pendulum the restoring force is proportional to the arc of displacement. This, however, was proved in 1673 or 1674, and it shows that Huygens was certainly the first to consider the theory of simple harmonic motion. The proof can in any event be obtained easily from his propositions, but it must be admitted that these are alien, in their original, severely geometrical, form, to the consideration of forces and physical conditions.

Part 3 of the "Horologium", "On the Evolution and Measurement of Curves", appears now scarcely appropriate in a physical treatise, since it deals exclusively with problems of pure mathematics. Huygens explained that he was so intrigued with the method of evolution of the cycloid that he could not resist the temptation to investigate the evolutes of other curves. As is well known, this work was completely original. Its somewhat unusual character may be traced to Huygens's habits of experiment: the idea of an evolute would occur to him when wrapping the thread along the cycloid 'cheeks' of his pendulum. Huygens showed that the evolute of a cycloid is another cycloid, and thus established a proof for the form of the metallic plates employed in the clock (Props. 5 and 6). In Proposition 7 he showed that the cycloid is four times the diameter of the generating circle.

Part 4 of the "Horologium" must be reckoned the most important, for this contained Huygens's treatment of the centre of oscillation of a compound pendulum—the first dynamical system ever studied. This problem was too complex for Galilei, and Descartes failed to do any more with "Mersenne's problem" than to give solutions for one or two special cases—and these were erroneous. Descartes imagined that the problem could be reduced intuitively to that of determining the centre of gravity of some related solid or plane. Not surprisingly, he did not give proofs for his 'solutions'.

Huygens's work, as published, gives few clues to the order of his discoveries. By 1664, however, it is clear that he knew the general formula for the length of the equivalent simple pendulum $x = \dfrac{I}{M\,b}$ where I is the rotational moment of inertia, M the mass, and b the distance of the centre of gravity from the axis of oscillation. Huygens began with a problem bequeathed by Galilei: to find the period of a pendulum consisting of two weights at different positions along the same thread. Huygens solved this by applying the results of his study of impact and assuming that the centre of percussion is identical with the centre of oscillation. In the course of this preliminary essay he made important use of the conception of work done or of potential energy. In the "Horologium Oscillatorium", this treatment of the linear compound pendulum is simplified by supposing the separate weights of the linear pendulum to be freed at some point in the swing; the heights to which the weights could then ascend

are calculated from their speeds. Huygens's argument then is that the work done in raising each of the weights through its own height is, in the sum, equal to the work done if the sum of the weights is raised through the distance of elevation of the centre of gravity. The fundamental principle that the centre of gravity of a number of masses cannot ascend of itself through any motion of the masses under gravity was used extensively by Huygens. It followed from this that the separate masses might have their centres of gravity brought to the height of the common centre of gravity "without the expenditure of any other force besides that which resides in the system".

This direct method of attacking the problem of the centre of oscillation was not suited to the study of plane and solid figures in general, however. Huygens's account of this part of his work is very involved, and the simplest statement that can be made about it is that he was in effect applying the general formula quoted above without having a general method of computing moments of inertia. In dealing with plane figures oscillating in a plane perpendicular to their own, he adopted a geometrical "method of the wedge" to evaluate $\int v.da$ where v is the velocity of any element δa as it passes through the mid-point of its oscillation. If one imagines perpendicular ordinates erected on every element of area, each ordinate representing v for that element, a solid figure, wedge-shaped and tapering to the axis, is constructed on the plane figure as base. The treatment of the problem rested on the identity of the centres of percussion and oscillation mentioned above. Huygens's plane figures were all symmetrical about a plane perpendicular to the axis, and containing the centre of gravity. In the course of his work Huygens made use of the equation on moments of inertia:

$$I_z = I_x + I_y;$$

and he was one of the first to do so. Proposition 12 demonstrates that the moment of inertia, I, is given by Σmr^2 and that this is constant for a given axis of rotation.

The culminating point of the "Horologium" is the determination of the centre of oscillation of a suspended sphere. Combining this with the result for a uniform rod, Huygens obtained the approximate radius of gyration for a clock pendulum, and worked out the equation for the effect of placing a small mass on the rod in the manner of a rider. The clock pendulum was in practice a compromise. A flexible ribbon at the top of the rod enabled the pendulum to follow a cycloidal curve for a small arc. It was assumed that the centre of oscillation travelled in this curve.

Scarcely remembered nowadays is Huygens's proposal (Prop. 25) to base a universal measure of length on the pendulum. The *pes horarium* was to be a third part of the distance from the axis to the centre of oscillation of the bob of a simple pendulum beating seconds. The size of the bob would, of course, be immaterial provided that the centre of oscillation was known. There is, however, in the "Horologium Oscillatorium" no indication that Huygens reckoned with the variation of the length of the seconds pendulum with latitude. At the date of publication Huygens was presumably uncertain about the conclusion to be drawn from the observations of Picard at Cayenne (1671–72). This expedition first brought back evidence on the shape of the earth. "The thing would certainly be very important and constitute a remarkable property of our pendulums . . ." wrote Huygens[2]. Hooke was quicker in perceiving the bearing of the observations on Huygens's proposals: the variation of the earth's gravitational field with latitude quite nullified the idea he emphatically stated.

This part of the "Horologium Oscillatorium" curiously enough, ended with an account of a method for determining g—a method which is greatly inferior to the use of a pendulum. In this a pendulum of known period is released simultaneously with a falling weight attached to a long strip of paper. The pendulum bob, blackened with soot, makes a mark on the paper strip after swinging through one half of its arc. This gives the distance fallen and the time interval taken. Huygens's result came out at $g = 30$ ft. 2 in. per sec. per sec. where 1 ft. = 1 *pes horarium.*

The fifth and last part of the "Horologium" is famous for the statement of thirteen theorems on centrifugal force. These, as is well known, influenced Newton, who, rather disappointed that he had not pursued his own work to the same conclusion, remarked: "What Mr. Huygens has published since about centrifugal force I suppose he had before me." The first five theorems in effect state the equation $F = \frac{mv^2}{r}$, and the last eight deal with the conical pendulum. A form of this pendulum is described in Part 5.

Huygens constructed clocks employing conical pendulums in 1659 and 1667, the latter when he had more fully investigated the laws of motion involved. Controverting Hooke's claims to the invention, he pointed out, what Hooke certainly did not know, that the conical pendulum should be so designed that all revolutions of the bob describe horizontal circles in the surface of a parabolic conoid with the axis vertical. Only then would all revolutions be isochronous.

The great contributions of the "Horologium Oscillatorium" may be summarized as the introduction of work and energy considerations in the solution of the problem of the centre of oscillation, the proof that the cycloid is the tautochrone, the study of evolutes and the theorems on centrifugal force. One might go so far as to say that Huygens recognized implicitly all the laws which Newton made explicit in dynamics: the work on centrifugal force required a grasp of the second law, the compound pendulum illustrated the third law applied in a difficult example. Not until the time of D'Alembert, remarked Whewell[3], was the representation of the laws of motion in their most general form fully achieved. Huygens, Mariotte, the brothers Bernoulli, de l'Hôpital and Brook Taylor all took a part in the history of this advance, but of them all Huygens made the greatest inductive contribution.

[1] There is a German translation: "Ostwald's Klassiker der Exakten Wissenschaften", No. 192, and one in French: "Œuvres Complètes de Christiaan Huygens", 18, published by the Société Hollandaise des Sciences (1934).

[2] "Œuvres Complètes", 18, 635.

[3] "History of the Inductive Sciences", 2, 59 and Chap. v.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By DR. F. R. MOULTON, Permanent Secretary

DURHAM (NEW HAMPSHIRE) MEETING

SINCE 1931 the American Association for the Advancement of Science has held two meetings each year, the annual meeting during the Christmas holiday week and a summer meeting, usually in June. The large annual meetings are held in cities able to provide accommodation for several thousand men of science and about sixty rooms for holding scientific sessions. The summer meetings are usually held in smaller cities offering exceptional attractions. In June 1938, the Association met in Ottawa, Canada. This year it held its meeting in Durham, New Hampshire, during June 23–27, in connexion with the celebration of the seventy-fifth anniversary of the founding of the University of New Hampshire. It will strike British readers as curious that the seventy-fifth anniversary of the founding of a university should be the occasion for a celebration. However, in September the Association will participate in the symposia organized by the University of Chicago in celebration of its fiftieth anniversary.

In certain respects the Durham meeting resembled some of the meetings of the British Association. It was held at a university in a small town surrounded by a delightful countryside. The sea was near by in one direction, and lakes and mountains in the other. Summer was at its loveliest and the vacation period was at hand. There was an air of leisureliness that is unusual in American meetings. There was music, and there were social functions and many tours and excursions.

Stated statistically, about a thousand persons attended the meeting and fifty-one sessions were held at which two addresses were delivered and two hundred and ten papers were presented. In addition, there were several round-table discussions, eleven special luncheons and dinners at most of which addresses were delivered, five demonstrations and exhibits, and thirty-four tours and excursions for scientific purposes. Several of these excursions were continued well beyond the period of the meeting. In fact, the botanists continued their excursion through the State of Maine for a week after the meeting closed.

For several years the section on social and economic sciences has taken for the general theme of its programmes for the summer meetings the racial origins and social and economic patterns of the various peoples of the regions in which the meetings are held. Since New Hampshire is one of the New England States, the present inhabitants of New England were the subject of the programme of the section. The Pilgrims landed at Plymouth Rock in 1620 and for nearly two hundred years most of the immigrants to this region came from England. During this interval an orderly, cultured and somewhat aristocratic society developed. Then, with the rapid development of manufacturing and because of difficult conditions in Europe, wave after wave of new immigrants poured into New England—the Irish, the Italians, the French-Canadians and smaller percentages from every country from the Atlantic Ocean to the Ural Mountains. Twenty-seven papers were devoted to discussions of the human, religious, political, social and economic problems that were raised by these mass transfers of populations, and by the sudden and complete change in their occupations and living conditions.

Perhaps the most thoroughly organized and

completely carried out programme was the symposium by the entomological societies on "Laboratory Procedures in Studies of the Chemical Control of Insects". The programme, which was presented at four sessions extending through two days, consisted of eleven principal topics which were formally discussed by invited leaders and informally discussed by other experts in the respective fields. It is expected that the Association will publish this symposium in the near future.

It would be erroneous and futile to pretend that the men of science who were gathered at Durham thought only of the niceties of mathematical theories, of the meteorology of New England, of the complex origin and formation of its mountains, of its fauna and flora, of the qualities and functioning of the human mind, of the complexities of society, of the progress in the medical sciences, and in agriculture and forestry. All these were considered, and although they were considered seriously they only caught the conscious attention and held it temporarily. Deep reverberations of a new *Blitzkrieg* were coming out of Russia, "nearer, clearer, deadlier than before!" Civilization was, and is, making history around a sharp curve, and freedom was, and is, being defended principally by the gallant people of one small island. In the presence of such a tide in the affairs of men the attention could not long be held fixed exclusively by the wavelets of small additions to scientific knowledge.

Yet science gives a perspective that is unique. It deals with great distances, long periods of time, tremendous forces. It sees in outline the evolution of life from amœba to man. Against the background of the struggle of all life for existence it looks on the tragic vicissitudes of human history. It finds in the lower animals the elementary characters that in more complex combinations determine the nature of man. It gathers wisdom from all the history of the world instead of from only its last illegible page. It has no early millennium to offer, but it can point out certain pathways that should be avoided and others that are promising. And this men of science of the American Association, as well as those of the British Association, regard as one of their responsibilities to society.

OBITUARIES

Prof. J. C. Philip, O.B.E., F.R.S.

JAMES CHARLES PHILIP, born at Fordoun, Kincardineshire, on February 12, 1873, was both a son and nephew of the manse. He went to Aberdeen Grammar School and afterwards to the University, where in 1895 he was Murray scholar. He was a pupil of Japp and probably went to Göttingen on the latter's suggestion to become acquainted with the new science of physical chemistry as taught by Nernst.

In 1897 he came to work under H. E. Armstrong at the Central Technical College in South Kensington. Armstrong, though very critical of the doctrines of Ostwald and Nernst, was anxious to know of them at first hand. Less than a year later he was able to place Philip at Cambridge with Heycock and Neville, then engaged on their classic work on the constitution of binary alloys, in the interpretation of which the phase rule was to prove so helpful.

Philip stayed at Cambridge for a while but seized the first opportunity to return to London to the Royal College of Science as demonstrator and lecturer in January 1900. Here he remained all his life, becoming assistant professor in 1909 and first professor of physical chemistry in 1913. This was one of the earliest chairs in this subject in Great Britain. When Prof. H. B. Baker retired in 1932 he was made director of the Laboratories of Inorganic and Physical Chemistry. He took part in the design of the new laboratories in Imperial Institute Road begun in 1906 and busied himself more and more in every form of college activity—both official and social. He served for six years, 1932–38, on the Senate of the University, and was dean of the Faculty of Science in 1934 and deputy vice-chancellor during 1937–38.

Besides his teaching, Philip was actively engaged in research largely in collaboration with a continuous succession of students. His investigations ranged over a wide field: the properties of non-aqueous solutions (especially of electrolytes in organic solvents); adsorption of dissolved substances and vapours on charcoal; determination of the dielectric constant of liquids; molecular refraction; freezing-point diagrams of binary systems; chemical fogs.

It is particularly to his credit that he left behind him a strong school of younger men who to-day make the Imperial College a prominent centre of physical chemical training and research. It was characteristic of him to encourage his younger men to follow their own varied bents, and he shared his research students among them.

He became a fellow of the Royal Society in 1921. An honour which pleased him greatly was the honorary degree of LL.D. from his old University, Aberdeen, conferred on him in July of this year.

During the War of 1914–18 he was secretary of the Royal Society War Committee and largely concerned with organizing the preparation of local anæsthetics in university laboratories. In recognition of this work he was awarded the O.B.E.

Philip threw himself wholeheartedly into the activities and organization of his profession. He was secretary of the Chemical Society during 1913–24, and held the very onerous position of chairman of the Bureau of Chemical Abstracts during 1923–32, in the formation of which he took a leading part. From 1939 until 1941 he was president of the Society of Chemical Industry, having been persuaded to occupy the office for a second year. He had taken office as president of the Chemical Society only a few months before his death. He added to his labours in 1938 by consenting to prepare a history of the Chemical Society appropriate to the celebration of its centenary. Both the Science Masters' Association (1929) and Section B of the British Association (1936) had claimed him as president.

Philip's record is one of unselfish and continuous work for others, for those causes which he judged worthy. He was a devoted and active Presbyterian and gave much time to the duties of his church. He taught and carried out researches and organized with all his ability and was happy in all he did. Of such a man Meredith says:

"You of any well that springs
May unfold the heaven of things,
Have it homely and within
And thereof its likeness win."

Perhaps Philip's greatest memorial is in the memory and affection of the students of South Kensington. He sought to know every student individually, played tennis with them, sang songs at their concerts and entertained them at his house while he inducted them into the tradition of the Imperial College. At one time or another he took an active part in the management of practically all the student activities. One could never say of him, in Milton's words:

"Above the rest
in shape and gesture, proudly eminent."

This devotion to the duty which lay at hand, coupled in earlier days with a reticence of manner, made it seem as if he matured late in life—the Philip of the last decade, secure in the highest positions of his profession, was found to have a charm and a sincerity and to possess powers of leadership which we all valued. He was never forceful or aggressive; such traits were alien to his character.

The story of what he did for the College is too long to relate here in detail—rather would we express it as in "Pilgrim's Progress":

"This place has been our second stage:
Here we have heard and seen
Those good things that, from age to age,
To others hid have been."

Philip retired from his professorship under the age limit rule in 1938. He was given many tangible expressions of loyalty and admiration, not least by the many old students whose careers he followed and who looked to him as a friend. The recall to duty followed almost immediately: he was summoned to act as deputy rector while Sir Henry Tizard was engaged on other work. When war came this position was both arduous and exacting, the more so as the College decided to remain in London and carry on its work. Philip slept there most nights and was always to be found at his post.

His devotion to duty made him take on other, equally strenuous duties at this stage, in connexion with the allocation of scientific and technical personnel to posts in the Services and in war industries.

He became chairman of Committees of the Royal Society and of the Ministry of Labour and National Service concerned with the institution and operation of the Central Register; he also accepted the chairmanship of the University of London Joint Recruiting Board. It is said that this last position involved his interviewing about six thousand young men for an average of fifteen minutes each during the last two years. To all these offices he brought soundness of judgment, endless patience and a firm determination that everyone should have a fair deal.

Too many tasks were piled on his broad and willing shoulders, and there is little wonder that his strength eventually failed. He was taken in the very height of his achievement, rich in all the honours of his profession, richer in the love of his friends. Perhaps it is better so, than to live on the "other side of the hill" as Walter Scott called it and see one's powers, physical and mental, growing less.

Philip's teaching and the example of his personal life was to emphasize the significance of those non-material values commonly termed moral and spiritual. As he said, "surely the finest things in human life are the most difficult to express or define".

Philip married Jane Henderson of Aberdeen and had a son and a daughter: such is the bald statement, but it conceals a bountiful married life; he would have achieved far less without the constant help and support of Mrs. Philip. And their philosophy:

"I am content with what I have
Little be it, or much."

E. F. ARMSTRONG.

We regret to announce the following deaths:

Prof. Victor Jellos, formerly of the Kaiser Wilhelm Institut für Biologie, Berlin–Dahlem, known for his work on heredity and genetics, on July 5, aged fifty-three years.

Prof. E. Kremers, emeritus professor of pharmaceutical chemistry in the school of Pharmacy, University of Wisconsin, on July 9, aged seventy-six.

Prof. E. E. Maar, professor of the history of medicine in the University of Copenhagen, aged sixty-eight.

Prof. Paul Sabatier, For. Mem. R.S., professor of chemistry in the University of Toulouse, who was awarded the Nobel Prize for Chemistry in 1912, aged eighty-six.

Eng.-Capt. J. Fraser Shaw, chief engineer of the Fuel Research Station, Department of Scientific and Industrial Research.

Mr. W. A. Taylor, O.B.E., formerly a superintending examiner at the Patent Office, on August 18.

NEWS AND VIEWS

The British Association

A MEETING of the Division for the Social and International Relations of Science of the British Association will be held, circumstances permitting, during September 26–28, beginning on Friday morning, September 26, at the Royal Institution, Albemarle Street, London, W.1. The general subject of discussion will be "Science and World Order". At successive sessions, speakers representing science in Britain, the Empire and other countries will deal with the following topics (The international aspects will be stressed throughout): September 26, "Science in Government" (morning), "Science and Human Needs" (afternoon); September 27, "Science and World Planning" (morning), "Science and Technological Advance" (afternoon); September 28, "Science and Post-War Relief" (morning), "Science and the World Mind" (afternoon).

At the conclusion of the meeting, the President, Sir Richard Gregory, will announce a charter of scientific fellowship, which has been drawn up by a Committee of the Division and adopted by the Council of the Association. Tickets of admission (without charge), accompanied by full particulars, will be forwarded up to the limit of accommodation available, to those who intimate their wish to attend, to the Secretary, British Association, Burlington House, London, W.1. Intimation should not be given by telephone. Applicants should state whether tickets are desired for all three days, or for any particular day or days. Applications should be made as early as possible, and in no event later than September 22.

German Crimes at Lwow

NEWS has just been received in London of the death, in deplorable circumstances, of Prof. Casimir Bartel, formerly rector and professor of geometry in Lwow Technical College and prime minister of Poland in 1926, 1929 and 1930. He was fifty-nine years of age. According to *The Times* of August 27, Prof. Bartel was shot by the Germans for conspiring with the Soviet authorities during the Russian occupation of Lwow. It is, however, known that Prof. Bartel refused to collaborate politically with the Russians, but did agree to co-operate solely in scientific and humanitarian matters. It was hoped that Prof. Bartel would leave Lwow after the outbreak of war between Russia and Germany, and become chairman of a committee in Russia to deal with Polish welfare problems, but he wished to remain at his college, where he was arrested a month ago. About sixty professors of the University and the Technical College at Lwow were arrested. They included Prof. S. Pilat, professor of petroleum technology, Prof. R. Rencki, professor of internal diseases, Prof. W. Sieradzki, professor of forensic medicine, and Prof. T. Ostrowski, professor of surgery. Their fate is unknown. Thus have the Germans repeated the same persecution of men of science and learning at Lwow which they carried out at Cracow, when a hundred and fifty university professors were sent to the concentration camp at Oranienberg.

State Bursaries in Science

IN order to meet the demands of the Services and of industry for technical officers, the Board of Education has established a scheme of State bursaries tenable at universities and at certain technical colleges. The demand is particularly pressing for men and women for radio work for which physics is essential; others will be required for posts needing qualifications in engineering and in chemistry. The bursaries will cover fees and maintenance allowances to meet the full cost of residence at the university or college at which the awards are held. The qualifying standard will be a pass in physics, chemistry, or mathematics in certain combinations in the higher certificate examinations. Applications are being accepted also from boys and girls who have passed the London Intermediate Science examination in the appropriate subjects.

Applications cannot as a rule be entertained from pupils who left school before the end of last term and are now in employment, nor will students at present attending universities and university colleges be considered eligible. The minimum age is eighteen years, unless the applicant possesses exceptional qualifications. It is expected that some of the holders of State bursaries may be able to qualify for a university degree before they are required for national service; others will have to relinquish their university course at the end of a year's training. The Board has promised that in suitable cases these will be considered after the War for such assistance as may be necessary to enable them to complete a degree course. Further information can be obtained from the Board of Education, Branksome Dene Hotel, Bournemouth.

University of London

On August 25 the headquarters of the University of London administrative staff will remove from Royal Holloway College, Englefield Green, Surrey, to Richmond College, Richmond, Surrey (telephone, Richmond 2301). The Matriculation and School Examinations Department of the University will remain at Highfield, Englefield Green, until the middle of September, when it also will remove to Richmond College.

The title of professor emeritus of physiology in the University has been conferred on Prof. Winifred C. Cullis on her retirement from the Sophia Jex-Blake chair of physiology at the London (R.F.H.) School of Medicine for Women.

Miss Esther M. Killick has been appointed to succeed Prof. Cullis. She has been since 1939 lecturer in industrial physiology at the London School of Hygiene and Tropical Medicine.

University of Poznan

According to Science Service, the former Polish University of Poznan, which has now become the University of Posen, reopened this summer under German direction and for German students. The city of Poznan is in the western part of Poland, which has been set aside for permanent and total German occupation; Posen is the German spelling of its name. Its university is one of the newest in Europe, having been founded in 1919. Before the outbreak of present hostilities, it had a student body of something more than five thousand.

A New British Scientific Journal

Imperial Chemical Industries propose to publish a new quarterly journal of science, and it is hoped that the first number will appear during the autumn of this year. The journal will be translated into at least three foreign languages and will circulate in all parts of the civilized world. Though published by Imperial Chemical Industries, it will in no sense be an advertising medium, but, by laying principal emphasis upon British contributions to science, will form part of the national war effort and as such has the approval of His Majesty's Government. Many distinguished men of science have already expressed their willingness to contribute to its pages, and the chief article of the inaugural number will be by the Astronomer Royal, Dr. H. Spencer Jones. Such a journal, especially in its translated forms, will undoubtedly contribute largely to the national war effort and we wish it every success.

First American High School of Science

The first "graduating exercises" of the New York High School of Science were held on June 26, with the commencement address delivered by Dr. Irving Langmuir. Diplomas were presented to the pioneer class of 130 boys. Every one of the graduates has signified his intention of pursuing further studies in science, leading to careers in research, engineering and medicine. The new high school was organized in 1938, with curriculum and faculty built around the idea of making science the central theme in education. Not only were science courses made the pivotal subject studied, but also such subjects as English, foreign languages, the social sciences, etc. were presented with primary reference to their relation to the natural sciences.

New York was combed for boys with special interest in, and aptitude for, science. Out of five thousand applicants, a student body of two thousand was selected. A rigorous entrance examination was held. The new school was opened in a building of the conventional school type, so that many changes had to be made, especially in the installation of additional laboratories, to adapt it to its new purpose. In addition, there is a visual instruction lecture room, a large library, an English workshop, a voice-recording studio, four mechanical drafting-rooms, a graphic arts shop, a music room, a gymnasium and a swimming-pool.

John Innes Horticultural Institution

The report of the Director of the John Innes Horticultural Institution for the year 1940 has just been issued. The War has affected all the departments, the reduction in personnel by war service and the replacement of research work by the growing of vegetables and drug crops and seed production have dislocated some of the activities. Nevertheless, the results obtained from experiments on incompatibility, parthenocarpy, production of polyploidy in plums, cherries and pears, heterosis, polygenetics and linkage, provide useful and important data. The cytological department has found that cold treatment, colchicine and starving the nucleus of nucleic acid are excellent methods for analysing the behaviour of chromosomes during division. The preparation of a list of chromosome numbers of more than a thousand tropical species will be of great value to future workers. The identification of several plant pigments has been made by the Biochemistry Department. It has been found that both the ivory and yellow forms of *Antirrhinum majus* contain apigenin, and that the yellow pigment probably is chalkone. The yellow pigment in *Papaver radicatum* is gossypetin.

A useful innovation is the publication of pamphlets —John Innes Leaflets—which explain in simple terms the lessons learnt from the experiments on composting, soil sterilization, incompatibility, sterility and time of flowering in fruit trees. Already ten thousand of the leaflets have been sold. These pamphlets, together with more than fifty scientific papers published during 1940, indicate that very creditable work has been done under adverse conditions.

Malaria in India

In a paper in the July issue of the *Asiatic Review*, Sir Alfred Chatterton states that the organization employed at the present time in anti-malarial work in India, where many millions of cases occur every year, are the Malaria Institute of India, the Indian branch of the Ross Institute, the malarial sections maintained by some of the provincial health departments, the medical departments of certain railways and a few voluntary associations, such as the Assam Medical Research Society and the Central Co-operative Anti-Malarial Society of Bengal. The Malaria Institute of India is the main centre for research and for the training of medical officers from all parts of India in anti-malarial work. By offering advice to Provincial Governments it plays an important part in co-ordinating work throughout the country. The

Indian branch of the Ross Institute, started in 1930, is mainly concerned with the control of malaria in the tea and coffee estates, rubber plantations, mines, sugar factories, cotton and jute mills and other industries in various parts of India. The chief function of the Central Co-operative Society of Bengal is propaganda, in which it has been very successful as it has 2.362 rural societies under its control. These various organizations co-operate freely both in general conferences and in joint inquiries and investigations.

Empty Space

Dr. Robert G. Aitken brings together some interesting information on this topic in Leaflet No. 148 issued by the Astronomical Society of the Pacific. The diameter of the universe made accessible by the 100-inch telescope is about 600 million light-years, and the 200-inch telescope will double the diameter of this sphere. In this smaller sphere there are 100 million stellar systems with an average content of 10^{10} stars, the diameters of which average about twice that of our sun. The stars fill about 10^{-26} part of space and it is believed that the space between the separate stellar systems—extragalactic space—is absolutely empty. In interstellar space, however, in which the stars are distributed at average distances of five or six light-years, electrons, protons, atoms, gas molecules, minute dust particles and also larger pieces of matter, ranging up to the size of meteorites, are known to exist.

There is so much space that the mass of this interstellar matter may be two or three times the combined mass of all the stars, and, with the exception of the larger pieces of matter, the interstellar particles produce a number of problems for the astronomer because of their effect in absorbing and scattering light. The light from the more distant stars passes through space laden with gas molecules, and the intensity of the stellar lines will increase with increasing distance—a fact which has been utilized in recent times to estimate the distances of these stars. Previous conclusions regarding the distances of the fainter stars based on the inverse square relationship must now be modified, and these distances may not be so great as astronomers believed a few years ago. Another important point is the greater absorbing and scattering effect upon the shorter violet rays, and in consequence myriads of stars cannot be photographed by the use of ordinary photographic plates. Many thousands of stars, the existence of which had been previously unsuspected, have recently been photographed with new red-sensitive plates—convincing evidence of the presence of interstellar matter. An enormous field for research in this direction lies before the astronomer.

Two Notable French Men of Science

On August 21 and 22 respectively occurred the centenary of the death of one distinguished Frenchman and the bicentenary of the birth of another. The first of these men is the eminent geologist and civil engineer Jean François d'Aubuisson de Voisins, who was born in the South of France on April 16, 1769, and died at the age of seventy-two on August 21, 1841. For four years D'Aubuisson was a student under Werner at the Mining School at Freiburg, and it was while in Germany that he studied the basalts of Saxony, an essay on which he published in Paris in 1803. This essay, in which the Wernerian doctrines were adopted, was reported on by Haüy and Ramond, who advised the author to inspect the basalts of Auvergne. This D'Aubuisson immediately did, with the result that in a paper "Sur les volcans et les basaltes de l'Auvergne", read to the French Institute in 1804, he abandoned many of the views he had hitherto held. "The facts which I saw", he wrote, "spoke too plainly to be mistaken; the truth revealed itself too clearly before my eyes, so that I must either have absolutely refused the testimony of my senses in not seeing the truth, or that of my conscience in not straightway making it known." D'Aubuisson's most important work was his "Traité de Géognosie", published in 1819, but he was also known for his investigation in hydraulics (1826–30) and his "Traité d'Hydraulique, à l'usage des Ingénieurs", an enlarged edition of which, published in 1840, was translated into English by Bennett and published at Boston, Massachusetts, in 1852.

The other Frenchman to whom we refer is the naval officer and navigator Jean-François Galaup de La Pérouse, who met a tragic fate following in the footsteps of Cook. La Pérouse was born at Albi, in the department of Tarn, August 22, 1741, and at an early age entered the French Navy. When serving in the *Formidable* under Conflans against Hawke, he was wounded and taken prisoner. During the peaceful years of 1764–78 he did all in his power to fit himself for his profession, and in the *Astrea* in 1782 showed much skill and resource in penetrating into the Hudson Bay and capturing several British posts. The reputation he gained led to his appointment to command the expedition comprising the ships *Boussole* and *Astrolabe*, which left Brest on August 1, 1785, to visit the Pacific. Crossing to South America, the ships rounded Cape Horn and from thence proceeded to California, China, the Philippines and Kamschatka. Sailing south again, La Pérouse reached Australia in the beginning of 1788 and from Botany Bay sent a letter to the French Minister of Marine giving particulars of the voyages he intended to make. From that time onwards for many years nothing was known of the fate of the ships. In 1791 Admiral d'Entrecasteaux in the *Research* and *Espérance* searched in vain for them, but some meagre information was secured by the ship *Hunter*, which, sailing from Bengal in 1813, visited Australasia. On board the *Hunter* was Peter Dillon (1785?–1847) who as captain of the *Saint Patrick* in 1826 discovered that the *Boussole* and *Astrolabe* had been wrecked off Vanikoro, north of the New Hebrides. Dillon made a second voyage in the *Research* and brought back to France many relics of the unfortunate expedition. For his services he was made a chevalier of the Legion of Honour. There is a bronze statue of La Pérouse at Albi, and his name has been given to the strait between Sakhalin and Yezo.

Edward Janeway (1841–1911)

Dr. Edward Gamaliel Janeway, a distinguished New York consulting physician, was born at New Brunswick, New Jersey, on August 31, 1841. He studied medicine at the College of Physicians and Surgeons, New York, and qualified in 1864. He spent some time after qualification at the Bellevue Hospital, New York, in the study of morbid anatomy, which formed an excellent foundation for his clinical work. In 1872 he was appointed professor of morbid anatomy and in 1881 of psychiatry and neurology at the Bellevue Hospital Medical College, where he succeeded Austin Flint in 1886 in the chair of internal medicine and held this post until 1892. From 1898, on union of the Bellevue Hospital Medical College with New York University, until 1907, he was clinical director of the amalgamated institution. In addition to general medicine he took a keen interest in public health, especially in the campaign against tuberculosis, and was for some time president of the National Association for the Study and Prevention of Tuberculosis. He died at Summit, New Jersey, on February 10, 1911. He made numerous contributions to periodical literature, but was not the author of any book. His son, Dr. Theodore Caldwell Janeway (1872–1917), professor of medicine at Johns Hopkins University, was the author of a book entitled "The Clinical Study of Blood-Pressure" (1914), which was a pioneer work on the subject.

The Night Sky in September

The moon is full on September 15 and there will be a partial eclipse, invisible at Greenwich, the middle of the eclipse occurring at 17h. 47m. U.T. Venus is an evening star and is in conjunction with the moon on 24d. 00h. Mars is a morning star, crossing the meridian at 2h. 54m. and 0h. 46m. at the beginning and end of the month respectively, and is in conjunction with the moon on September 9d. 02h. Jupiter is a morning star and crosses the meridian at 6h. 32m. and 4h. 48m. on Sept. 1 and 30; the planet is in conjunction with the moon on Sept. 13d. 18h. and will be 5° N. of the moon. Saturn is a morning star and souths at 4h. 12m. in the middle of the month. On Sept. 11d. 22m. it is in conjunction with the moon and will be 3° N. of the moon. New moon occurs on Sept. 21 and there will be a total eclipse of the sun, invisible at Greenwich. The path of totality passes along the northern end of the Caspian Sea, Turkestan, Central China, and the western part of the Pacific. The longer evenings provide an opportunity for viewing the Milky Way, the great bifurcation occurring in Cygnus and extending along the galactic equator. The eastern portion can be seen running through Aquila, Scutum, Sagittarius and Scorpio, where the broken western stream partially unites with it. In the late evening the beautiful group of stars in the constellation of Taurus—the Pleiades—can be seen. Their rising with the sun is referred to by the Greek poet, Aratos, as the harbinger of summer, and their rising at night, that is, after sunset, indicated the coming of winter. The variable star, Algol, is well placed for observation throughout the whole night and its rapid fluctuations in magnitude are always a source of interest. The pride of the Constellation of Andromeda—the Great Nebula of Andromeda—is visible to the naked eye and can be easily recognized close to the star ν Andromedæ. It looks like a 'fleecy' star, but is spiral in structure and is a great universe like our galaxy, about 870,000 light-years away, containing hundreds of millions of stars. In the outer portions are many stars of the Cepheid variable type, so valuable for the determination of distances.

Announcements

A German scientific institute has recently been opened at Madrid.

The Swiss Society for the Investigation of Nature will hold its 121st annual meeting at Basle during September 6–8.

Dr. Andrew F. Skinner has been appointed successor of Prof. W. W. McClelland in the associated posts of Bell professor of education in the University of St. Andrews and director of studies at the St. Andrews and Dundee Training Centre.

The Australian Government proposes to proceed immediately with the provision of four distilleries costing £1,250,000 for the production of power alcohol from wheat. The distilleries will be constructed in New South Wales, Victoria, Western Australia and South Australia. Each will have a capacity of three million gallons a year.

The College of Physicians of Philadelphia have awarded the Alvarenga Prize to Dr. John J. Bittner, of the Roscoe B. Jackson Memorial Laboratory, for his studies on cancer.

The Annual Congress of the Ophthalmological Society of the United Kingdom will be held in Cambridge on September 4 and 5, when Drs. O. M. Duthie and S. Zuckerman will open a discussion on ocular injuries resulting from the War. Further information can be obtained from Mr. Frank Law, 30, Devonshire Place, W.1.

The Committee of Privy Council for the Organization and Development of Agricultural Research has appointed, to fill vacancies caused by normal retirement, Major James Keith, who is the chairman of directors of the North of Scotland Bank, and owner of extensive farming areas in Norfolk and Aberdeenshire, and, after consultation with the president of the Royal Society, Prof. F. T. Brooks, professor of botany in the University of Cambridge, and Prof. D. Keilin, Quick professor of biology in the University of Cambridge, as members of the Agricultural Research Council. The Council of Privy Council has also appointed, to fill two other vacancies, Prof. J. A. Scott Watson, Sibthorpian professor of rural economy in the University of Oxford, and, after consultation with the president of the Royal Society, Prof. C. R. Harington, professor of biochemistry in the University of London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

"The Philosophy of Physical Science"

IF I return to this question, it is because I am so deeply impressed by its importance[1]. If Sir Arthur Eddington's theory is sound, its consequences are tremendous—to physics, to philosophy and to humanity. A peculiarity of the situation is that there can be no middle way; the theory must be either entirely right (apart possibly from unimportant details) or entirely wrong.

In his letter to NATURE (in which, incidentally, I do not find a single one of my objections answered) Eddington seems to me to have himself supplied proof that his theory is wrong. He agrees that the Michelson-Morley experiment disclosed one of the "brute facts" of Nature; thus we may, without logical inconsistency, imagine it having turned out otherwise than as it did. He then discusses "the situation which would arise if the experimenters have let us down badly and the true result is that which Michelson originally expected". He says this would indicate that "there is a strain depending systematically on the velocity". The essential point is that, however we interpreted the experiment, there would be a velocity disclosed by it, so that relativity would go up in smoke. There is no logical inconsistency in this, and yet, if Eddington's scientific epistemology had been sound, it would have been impossible to imagine such an event without logical inconsistency.

For we do not discuss the situation which would arise if someone were to discover the largest prime number, or two integers of which the ratio is $\sqrt{2}$, because we know, and can prove, that both events are impossible; we cannot imagine them happening without logical inconsistency. Eddington can only maintain his scientific epistemology by proving that it is equally impossible to imagine special relativity, Heisenberg's uncertainty, etc., being different from what they are. Instead of proving that certain events are unimaginable, Eddington starts imagining them.

Surely, however, the simplest and cleanest test case is not the Michelson-Morley experiment, but the finiteness of the speed of light. This is obviously very fundamental (in Eddington's sense), being an essential part of the theory of relativity, and it contains no jungles of "bogies" or "tail-chasing" in which to get lost. If we cannot discover any epistemological proof of this, Eddington's theory obviously falls. I cannot discover such a proof. Does Sir Arthur Eddington know of one?

J. H. JEANS.

Park House,
Wanstrow,
Somerset.

[1] NATURE, 148, 140 (1941).

IT appears that scientific men are divided into two classes: the experimental type and the theoretical type. The difference would seem rather a matter of temperament than of necessity. Perhaps it would be wiser to separate them into two other classes which are rather of the same kind: those who are model makers and those who deal purely in abstract ideas and the essential relation of things.

There is no reason to place these two classes, as Prof. Stark has done, in their order of merit, and to use this order to bolster up a political creed, because it is quite clear to those who know the history of science that both types are needed in the development of physics. Both classes have their limitations, and an analysis of the subject is bound up with one's ultimate scientific philosophy.

The model makers are rather at the mercy of irrelevant analogies, which can be avoided only if essentials are related, as in the group theory, for example. The analogies, in these cases, are good servants but bad masters. Again, makers of models manufacture mistakes and difficulties. Many examples could be cited. One particular case that has come to my notice is connected with the idea of the group velocity of a set of waves. If we look at the ripples made by a stone on the surface of a pond, we often see that whereas the group of wavelets moves with one velocity, the crest of each individual wave moves with another one. A group velocity can be approximately defined which only differs from the phase velocity when this is a function of the frequency. Group velocity does not really exist, but is a close approximation in certain conditions, and becomes rather indefinite when component waves are differently attenuated.

In a definite problem, say the calculation of how a group of waves arrives at a distant point, if the problem is definitely stated, the answer can be just as definitely expressed. A difficulty is manufactured if the problem is put in the form: The group is sent out. At what time will it arrive at a distance x, say? An indefinite answer is involved because an indefinite group velocity is used in the question.

Similar examples are the quantum theory of dynamics, the mechanical theory of the ether, etc. In the former, the model of an electron rotating about a nucleus, in the same way as the earth rotates about the sun, gives rise to such questions as where the electron is at any time. This is a meaningless question, suggested by a false analogy. It is put in such a form that it implies relations that do not belong to it. It is like the question: Have you stopped beating your wife?

All observable quantities, for example, the spectra of the elements, etc., can be expressed in terms of the quantum theory in a perfectly definite manner, as in the preceding group velocity example. The questions as to the individuality of the electron, which have puzzled so many physicists, are not really relevant.

A method of procedure can be postulated by which a definite answer is given to a definite question. This is the correct theoretical basis. A freedom from the fetters of mechanics is necessary to develop many of our new theories, which are not built in the image of molar mechanics, the only ones which the model-makers can understand.

It is the theoretical side of physics which is so necessary to free us from preconceived ideas. But theory alone is not enough. It is difficult to see how the theorist could invent all the living realities which it is his business to analyse. The experimental facts must come first. Eddington seems to take rather an extreme view of this case, as if it were possible, by epistemology and epistemology alone, for the theorist to deduce all the essential relations—all the fundamental constants in relativity, quantum theory and non-Euclidian geometry—without reference to any facts. It is probably a matter of theoretical power and efficiency whether this can be achieved, but there is a tendency towards it.

Although experiment is necessary, it is encouraging to realize that a large number of experiments are very often unnecessary, inasmuch as further experiments tend to confirm the previous ones; and it is often found that an experiment on a matter which seems entirely outside the original scheme is merely the same experiment as the previous one repeated, and that if we had sufficient theoretical power, we should realize that the two experiments imply the same thing. There is a tendency, therefore, to reduce experimentation in proportion as our theoretical power increases. If we could rely on this completely, only one experiment, to find out which point the curve goes through, so to speak, would be necessary. (I have been accused of drawing curves through one point only!) All that is necessary is to fix, say, the value of the ordinate at some specified value of the abscissa.

It is encouraging to think that experimenting, although necessary at the present moment, and probably the quickest way of getting results, should become less and less necessary as our theories improve. It may be that we shall reach a final state, as implied by Eddington, in which all the constants of nature are interrelated, and can be fixed from epistemological considerations alone.

T. L. ECKERSLEY.

Weatheroak,
Danbury,
Essex.

A CORRESPONDENCE between two men of such astronomical mental calibre as Jeans and Eddington, firing long-range shots at each other, should, I suppose, be read in silence and with respect by the ordinary man in the street. It is indeed very enjoyable in these days to have such a discussion, but first of all we must thank Jeans for the very human confession that he had been "re-reading" Eddington's book. It is comforting to think it was not just our fault we did not get it all the first time.

Jeans sums up Eddington's contention in paragraph 2 by saying that "all those laws of Nature that are usually classed as fundamental, as well as the values of the constants of Nature, can be foreseen 'from epistemological considerations, so that we can have *a priori* knowledge of them' ". "*A priori*" knowledge is given, quoting Eddington again, as "knowledge which we have of the physical universe prior to actual observation of it". From this it is fair to say that Eddington claims that fundamental laws are objective, yet in his answer towards the end he states that there is no such thing as a truly objective law. Eddington should, therefore, challenge Jeans's summary of his main contention, yet he does no such thing.

I have always regretted the Michelson-Morley experiment. Things were perfectly satisfactory before their distressing negative results. I feel we are not at the end of this story, just as we are not at the end of the story that the red shift in the spectrum means receding speed, unless we tie ourselves to the Hilaire Belloc creed and "never, never let us doubt, what nobody is sure about". To say that without the Michelson-Morley experiment we should find ourselves "faced with a universe far more complicated than we have lately imagined" can only be agreed to by those who can dart with such facility from physics to metaphysics.

Finally, a protest against 'plugging' the word 'epistemological'. It is neither pronounceable nor understandable.

J. T. C. MOORE-BRABAZON.

81 Albert Hall Mansions,
S.W.7.

SIR JAMES JEANS proposes the finiteness of the velocity of light as a test case. I answer: Certainly this is *a priori* knowledge, but of a rather trivial kind. We know *a priori* that the velocity of light is not infinite, just as we know *a priori* that the velocity of light is not blue or hexagonal or totalitarian; it is not the sort of thing to which these terms could apply. The alternatives "exceedingly large" and "actually infinite" concern only the abstract quantities which are the theme of pure mathematics; this is equally true of the alternatives "exceedingly small" and "actually zero". No such alternatives exist for physical quantities defined in terms of observation. When an *observer* sets out to determine the velocity of light, an infinite result is not among the possible alternatives; and if he announces that he has found the velocity to be, not merely exceedingly large, but actually infinite, we know *a priori* that the announcement is untrue.

In so far as the existing relativity theory rests on the assumption that the velocity of light is not infinite it is safe from experimental contradiction. In regard to the aspect in which it is not so immune, Jeans's remarks seem to me mainly reiterative, since he again ignores the difference between identification by description and identification by pointing. It is a logical impossibility that the Michelson-Morley experiment should give a null result in the conditions *described*; but the possibility imagined is that a bogey, supposed to have been laid, has come to life again, so that the conditions described are not those which have been *pointed out* to the experimenter. Similarly, it might have turned out that the velocity of light did not agree with the ratio of electrical units; in that case we should have had to await the discovery of Hertzian waves before we could see how electromagnetic wave theory applied. When Dirac's "holes" were first put forward they were identified with protons; but brute facts were discordant, and the hole theory went up in smoke. That was because the hole described was not the proton pointed out. Later the positron was discovered, and it was seen how the hole theory applied.

Since these letters will be read by many who are unfamiliar with the basis of the epistemological theory, it seems desirable to explain briefly why a scheme of laws arrived at in an *a priori* way is expected to coincide with the scheme arrived at by analysis of observational knowledge. The development of fundamental physics must go on and on, either steadily

or by a succession of revolutions, until the physicist has (in his limited view) reached the bottom of things. The important question is: Will he recognize "the bottom of things" when he reaches it, and can we already say what are the criteria by which he will recognize it ? If so, we can reverse the usual order of inquiry and begin with these criteria. We can, for example, work out the properties of the "particles" which, according to these criteria, could be accepted as really elementary structural units. In that way we develop a scheme of laws relating to the concepts in terms of which phenomena are ultimately to be described, confident that the physicist, who is working his way down from the top, will come to this scheme. Any other scheme could only be a temporary resting-place from which he must be driven by the intellectual urge which started his inquiry. Whether this will succeed as a practical method—whether it is the short way round or the long way round—cannot definitely be foretold; but it is found by trial to be the short cut, unless we have been greatly deceived. If we imagine experimental results to have turned out differently, we eliminate the evidence that it is a short and (in the present state of knowledge) practicable method; but we do not impugn its validity.

In reply to Lieut.-Colonel Moore-Brabazon, I do not see how the statements (which are, I think, a fair summary of my main contention) constitute a claim that the so-called fundamental laws are objective; I concluded that they are subjective. I fully agree with Mr. Eckersley's letter.

A. S. EDDINGTON.

The Observatory,
Cambridge.

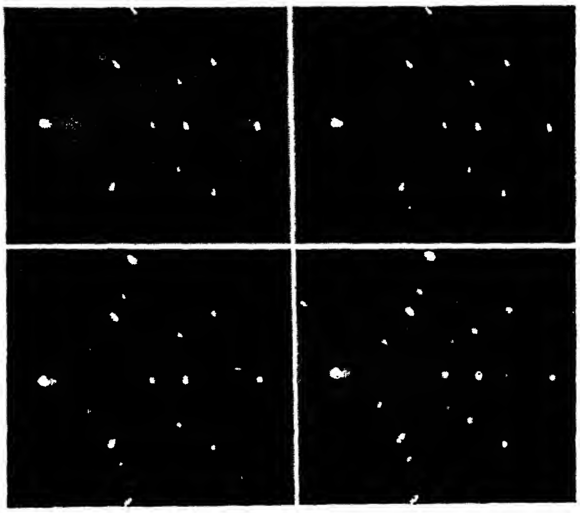
Temperature Study of the Diffuse X-Ray Diffraction by Diamonds

IN a recent letter in NATURE[1], we pointed out that all diamonds show one kind of ("primary") diffuse X-ray diffraction, associated with the ordinary {111}, {220}, {113}, etc., reflexions on Laue photographs, but that only Type I diamonds show the special ("secondary") diffraction, the characteristic appearance of which takes the form of fairly sharp streaks or triangles of spots. The suggestion was made that these two types of diffraction, though associated with each other and with the Laue reflexions, may have different origins. This is now supported by the following new experimental facts. First, in contrast to the primary diffuse spots, the *secondary* effects vary considerably in intensity even for diamonds of similar shape and size (Type I diamonds, however, always show some effect, whereas Type II show none). Secondly, it is found that, whereas this secondary diffraction is only slightly affected in intensity by a temperature change of more than 800° C., the *primary* diffraction (for diamonds of both types) is much more strongly temperature-sensitive.

The accompanying illustrations are typical of many taken using various specimens, changing crystal orientation, time of exposure, etc. Photographs (*a*) were taken with a small octahedral diamond of Type I, at 650° C. and at 30° C. respectively, under similar conditions of position and exposure time. The primary diffuse spots corresponding to (111) copper $K\alpha$ and β, and (113) copper $K\alpha$ reflexions are clearly much stronger at the higher temperature; the secondary diffuse spots (three (111) copper $K\alpha$, three (111) copper $K\beta$ and two (113) copper $K\alpha$) show definite, but less marked enhancement. It is interesting to note that the third point of the (113) "triangle" does not appear even at high temperatures.

Photographs (*b*) were taken with a very thin diamond plate, also of Type I, at 30° C. and at − 180°C. The crystal orientation was changed a little from the (*a*) position, in order to intensify the primary diffuse spot in the room temperature photograph; this, however, weakened the (113) diffuse reflexions, which are no longer reproducible. For the low-temperature photograph the specimen was completely bathed in a direct, continuous stream of liquid oxygen. In order to allow for absorption and scattering of the incident X-rays by the liquid oxygen, the exposure was increased until the Laue spot and background intensities were obviously stronger than those of the room temperature photograph. Even so, the primary diffuse spot has practically disappeared, the secondary spots being weaker than before but still quite distinct.

(*a*) 650° C. 10 min. θ = 18° (*a*) 30° C. 10 min. θ = 18°



(*b*) 30° C. 10 min. θ = 18·6° (*b*) − 180° C. 15 min. θ = 18·6°.

Similar experiments on Type II diamonds showed the same weakening of primary diffuse diffraction at low temperatures, and other photographs verified this for {220} and {113} diffuse reflexions. All these temperature changes were reversible.

Sir C. V. Raman and others[2,3] have reported a negative result for low-temperature experiments on diamond, but without the publication of photographs or of data which would indicate whether they were, in fact, observing primary or secondary diffraction.

The *primary* diffuse spots, observable and temperature-sensitive for both types of diamond, would appear to correspond closely to the diffuse spots observed for all other crystals under suitable conditions of temperature, orientation and wave-length of incident radiation. It seems obvious, however, that the *secondary* spots and streaks on photographs of Type I diamonds, however interesting in themselves, can scarcely be taken as typical of diffuse diffraction in general, since the counterpart of the triangles has not yet been observed for any other substance, while streaks are relatively uncommon. It is noteworthy that the selective Bragg reflexions

from diamonds giving strong secondary effects were relatively weak, being barely visible on a fluorescent screen; those from diamonds giving very weak or no secondary diffraction were much stronger, the (111), (220), etc., reflexions being visible on a fluorescent screen in broad daylight not only in the "characteristic" position but also throughout the entire range of Laue reflexion. This confirms the observation that strong secondary diffraction is associated with powerful extinction effects.

K. LONSDALE.
H. SMITH.

Davy Faraday Research Laboratory,
Royal Institution,
London, W.1. July 28.

[1] Lonsdale, K., and Smith, H., NATURE, 143, 112 (1941).
[2] Raman, C. V., and Nilakantan, P., *Proc. Ind. Acad. Sci.*, 11A, 396 (1940).
[3] Raman, C. V., Nilakantan, P., and Rama Pisharoty, P., NATURE, 147, 805 (1941).

Determination of Sex in Scalpellum

SEXUAL conditions in the Cirripedia are very varied[1]. They comprise such species as:

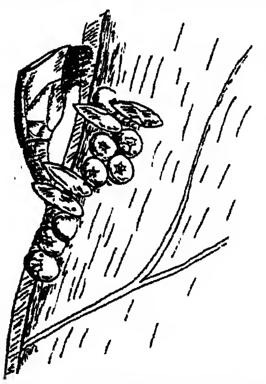
(1) Hermaphrodite forms with 'complemental' males, for example, *Scalpellum scalpellum, Ibla cumingii*;

(2) Hermaphrodites with sterile complemental larvæ, for example, Rhizocephala;

(3) Hermaphrodites only, for example, most Pedunculata (Lepas, Pollicipes, etc.), Operculata (Balanus, Coronula, etc.), Ascothoracica;

(4) Females with complemental males, for example, *Scalpellum velutinum, S. ornatum, Ibla quadrivalvis*, Acrothoracica.

The chromosomes of *Lepas anatifera*, which falls into group 3, were examined by Witschi[2]. He found the diploid number to be 26 and showed that no distinguishable sex chromosomes were present.



GROUP OF COMPLEMENTALS ATTACHED TO THE MANTLE OF A HERMAPHRODITE *Scalpellum scalpellum*, INCLUDING FOUR CYPRIS LARVÆ, NINE DWARF MALES AND ONE QUASI-HERMAPHRODITE. (× 12.)

I have examined the chromosomes of *Scalpellum scalpellum*, which falls into group 1. The diploid number of 32 was found in spermatogonia of complemental dwarf males and of hermaphrodites. No sex chromosomes can be distinguished at meiosis, the haploid number being 16.

Gruvel[3] observed oogonia in the complemental males of *S. peronii*, which also falls into group 1. I have seen the same in *S. scalpellum*. Moreover, one hermaphrodite of *S. scalpellum* which I received from Plymouth had an unusually large number of complementals. Of these four were unmetamorphosed cypris larvæ, nine were typical degenerate dwarf males, and one excluded from the male-containing pocket of the hermaphrodite, had the structure of a small hermaphrodite (see accompanying illustration).

The absence of sex chromosomes, presence of oogonia in the complemental males and this odd hermaphrodite-like complemental point to an environmental control of sex determination such as that existing in Bonellia[4]. I would suggest, therefore, that in *Scalpellum scalpellum* and Cirripedes of its type all larvæ are potential hermaprodites (instead of female as in Bonellia), but those which become parasitic on adult hermaphrodites develop as functional males only and go no farther. Since the breeding system involving complementals is widespread in the Cirripedes, it may further be suggested that this type of sex determination is primitive for the group.

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John Innes Horticultural Institution,
Merton, S.W.19. Aug. 2.

[1] Darwin, C., "A Monograph of the Sub-class Cirripedia" (London, 1851 and 1854).
[2] Witschi, E., *Biol. Bull. Woods Hole*, 68 (1935).
[3] Gruvel, A., "Monographie des Cirrhipedes" (Paris, 1905).
[4] Baltzer, F., *Mitt. Zool. Stat. Neapel*, 22 (1914).

Albert Hall Acoustics

THE changes made to house the recent season of Promenade Concerts have affected the appearance more than the acoustics of the Albert Hall. The subject has been discussed periodically ever since the Hall was built, but the oval ground plan and the great height are insuperable difficulties with reflecting surfaces. Most of the changes proposed, including that of Bagenal and Wood illustrated on p. 65 of their "Planning for Good Acoustics", showing the source of sound placed far above ground-level, attempt to preserve the full seating capacity of the Hall. Recently conditions have changed considerably. For some time pugilists and politicians have been the chief users of the full capacity of the Hall. But now there are a number of recognized sporting-centres in London and politicians can address even larger audiences through the radio. Musicians have, however, lost the Queen's Hall and other concert halls.

It would appear, therefore, that, when construction takes the place of destruction, the principle of 'divide and rule' could with advantage be applied to the recalcitrant acoustics. One half of the building could be used for a concert hall seating about five thousand, the number said to be needed for unsubsidized orchestral concerts in London. The remainder could be cut up to house smaller concert and recital halls, studios, a musical library, cafés, cloak rooms, ventilating plant and other needs of a musical centre. The volume of the Hall is adequate for all these needs. Although the fan shape is one of the simplest to plan acoustically, suggesting a division into wedge-shaped sections, like cutting a cake, the actual details of the division would be more a matter of structural engineering. Drastic changes of ground plan are essential. The most difficult acoustical problem would be the sound insulation of the different halls so that, if needed, they could be used at the same time. The division of the Hall would provide excellent support for roof gardens, like some of those in New York, where music and drama could be enjoyed out of doors in the summer time. The gardens would be well out of the range of appreciable traffic noise, and carefully planned stone wall screens could act as sound reflectors as in the typical Greek theatre.

Success would probably be best ensured by employing engineers and physicists under the direction of a fanatically functional architect.

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A PHOTOGRAPHIC METHOD OF ESTIMATING THE MASS OF THE MESOTRON

By Dr. D. M. Bose and Biva Choudhuri
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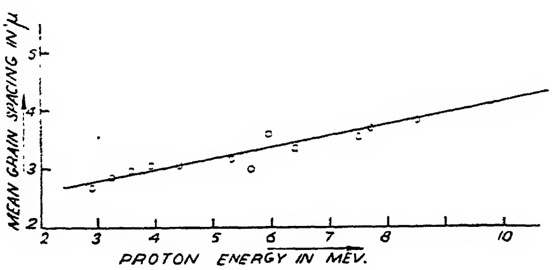
In a communication in Nature[1] it was concluded that the heavy ionization tracks found in Ilford New Halftone plates kept exposed to cosmic rays at Sandakphu (12,000 ft.) were chiefly due to mesotrons. The basis of this conclusion was a comparison of the mean grain spacing and curvature of tracks due to cosmic rays with tracks due to protons of known energies on similar plates.

In the present communication an account is given of a method of estimating the mass of these particles, presumably mesotrons. Usually three independent measurements are necessary to specify completely a moving charged particle, namely, its charge, mass and velocity. We start with the assumption that these particles are singly charged. We have determined the energy of these particles from their mean scattering and also their velocities as function of the mean grain spacing along their tracks. For the first we have made use of the formula recently given by Williams[2] connecting the mean energy W and the mean scattering $\bar{\theta}$ suffered by fast charged particles in a thickness t of a medium containing N atoms per c.c. with nuclear charge Ze. As will be seen later, the energies of such particles vary between 0·4 and 1·6 Mev., and the nuclear charge is low, so that the scattering is taken to be due only to Coulomb forces and that the use of Born's approximation is valid, and that the non-relativistic form of the equations can be used.

The mean deflection

$$\bar{\theta} = \{3{\cdot}69+0{\cdot}28 \log_{10} (Z^{4/3} \rho t/A\beta^2)\} \frac{Ze^2}{W} \sqrt{Nt} \ldots (1).$$

Since the photographic emulsion is heterogeneous in composition, we have assumed that the actual distribution of atoms of different kinds in it is replaced by one kind of atom of mean nuclear charge Ze and mean atomic weight A. These are estimated from a knowledge of the density ρ of the emulsion and its percentage composition as given by Wambacher[3]. It is found that $\rho=2{\cdot}89$, $Z=6{\cdot}2$ and $A=12{\cdot}6$. We have measured the total deflection θ suffered by a group of particles having a given mean energy and traversing a total thickness of emulsion varying between 0·33 and 0·09 cm. For the large number of encounters which take place under such conditions, $\frac{|\theta - \bar{\theta}|}{\bar{\theta}} \ll 1$; that is, for θ in equation (1) we can write θ. Having thus determined the value of $W=\frac{\mu}{2}\,\overline{v^2}$ of the mesotrons corresponding to a given mean grain spacing, we proceed for the second part of the investigation to determine the kinetic energy of protons having the given mean grain spacing along their tracks, in the same kind of emulsion. Our procedure is based upon the assumption that in such emulsions particles of different masses, but with the same charge and the same initial velocity will have the same mean grain spacing along their tracks. According to the accepted theories, the ionization loss of different particles with the same charge in a given medium depends only on their velocities. Such particles may have different ranges, but the mean grain spacing along their tracks will be the same, if they start with the same initial velocity.



We have prepared a calibration curve showing the mean grain spacing along the tracks of protons as a function of their initial energies. For this purpose we have produced recoil protons in the emulsion using neutrons of different energies produced by a radium-beryllium source. It has been found[4] that these neutrons have several discrete energy values; our own results are in general agreement with those of Blau[5], who also used the photographic plate. We have used proton tracks with ranges in air of 10–90 cm. and of energies between 2·25 and 9 Mev. After several trials we found that the most satisfactory calibration curve could be obtained by plotting the mean grain spacing along the proton tracks belonging to each energy group as a function of the corresponding energy. The calibration curve in the accompanying graph was found to be a straight

	(i) No. of tracks	(ii) (a) Mean grain spacing μ	(ii) (b) Mean μ	(iii) Total track in emulsion	(iv) Total Scattering	Energy in Mev. (v)(a) Mesotron	(v)(b) Proton	Mass of Mesotron
A.	1–20	6·9—4·9	5·7	0·25 cm.	22° 33′	1·575	18·5	$173m_0$
	21–49	4·8—3·7	4·2	0·33 cm.	52° 2′	0·776	10·5	$149m_0$
	50–86	3·6—2·5	3·3	0·29 cm.	86° 16′	0·434	5·65	$158m_0$
B	1–16	5·8—3·9	4·3	0·108 cm.	16° 37′	1·40	10·7	$265m_0$
	17–58	3·8—2·5	3·5	0·26 cm.	55° 1′	0·652	6·7	$198m_0$
C	1–6	6·3—4·8	5·4	0·086 cm.	16° 14′	1·273	17·0	$153\ m_0$
	7–18	4·5—2·8	3·5	0·100 cm.	40° 6′	0·555	6·9	$167m_0$

Mean of A and C $(160{\cdot}2 \pm 4{\cdot}3)\ m_0$

A : Plate kept in Sandakphu (12,000 ft.) under air.
B : Plate kept in Sandakphu (12,000 ft.) under 20 cm. of water.
C : Plates kept at Phari-Jong (14,500 ft.) under air.

line, and we felt justified in extrapolating it to the values of mean grain spacing found in the cosmic ray plates.

In the accompanying table are the data from which the mass of the mesotron has been estimated. We have divided the tracks on the plates into groups, the range of variation of the mean grain spacing in each is given in ii (*a*) and the resultant mean in ii (*b*). The total length of tracks in each group is given in (iii), and their total deflection due only to multiple scattering in (iv). The mean energy of each group of mesotrons as calculated with the help of formula (1) is given in v (*a*) and of protons with the same mean grain spacing as obtained from the accompanying graph in v (*b*). The last column gives the calculated values of the mesotron mass. It will be seen that fairly consistent values of μ are obtained from (*A*) and (*C*) in plates exposed under air, while with those obtained from (*B*) for plates exposed under 20 cm. of water, the values are consistently high. This is understandable, since by collision of the high-energy neutrons present in the cosmic ray with the hydrogen atoms contained in the 20 cm. layer of water, fast recoil protons are produced, and the scattering observed is due to a mixture of such protons with the mesotrons.

The method described above is a statistical one based upon a number of assumptions, averages and extrapolation. The presence of protons cannot be entirely excluded from such measurements. It is surprising, therefore, to find how the measured values of μ fall within the range of the best determinations by other methods[6]. It remains to be investigated whether the photographic method can be further improved into a precision method of determining the mass of μ. The results obtained are important in other respects; it has enabled us to verify our previous surmise that the star-like tracks found in our photographic plates are due to secondary mesotron showers produced chiefly by cosmic ray neutrons. This and the presence in such showers of three-, four- and five-star tracks in approximately equal numbers are results which do not appear to be capable of interpretation in terms of existing theories.

A detailed account will appear in the *Transactions of the Bose Institute.*

[1] NATURE, 147, 240 (1941).

[2] Williams, E. J., *Proc. Roy. Soc.*, A., 169, 539 (1939).

[3] Wambacher, *Phys. Z.*, 39, 888 (1939).

[4] Dunning, *Phys. Rev.*, 45, 586 (1934); Bonner, Mott and Smith, *Phys. Rev.*, 46, 258 (1934).

[5] Blau, *J. Phys. et Rad.*, 61 (1934).

[6] Bethe, *Phys. Rev.*, 57, 260 (1940) estimates that the most reliable measured values of μ lie between 150 and 220 m_0. When certain corrections are made, it is expected that the former will be increased by at least 10 per cent.

FOOD AND INCOME

By D. CARADOG JONES

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A REPORT, published under the title "Food and the War", by the Edinburgh Branch of the Children's Nutrition Council*, gives an account of a study of the expenditure of a sample of families of the unskilled labouring class, made by voluntary workers during the period April–November, 1940. The object of the inquiry was to determine whether their incomes sufficed to purchase for these families an adequate diet as judged by two well-known standards, the first defined in the Report of the British Medical Association's Committee on Nutrition (1933), the second in the League of Nations Report on the Physiological Bases of Nutrition (1936, II B.4). Since the families were chosen solely on the ground of readiness to co-operate and lowness of income—43 per cent had less than 50*s*. a week coming in and only 11 per cent had £4 or more—the main result of the investigation might be regarded as a foregone conclusion. Despite this fact and the small size of the sample studied, the figures and the inferences drawn from them are not without interest.

Of the 103 families visited 12 were on public assistance; in 38 the head was absent from home on war service, in 25 the wage earner was a labourer; the remainder are classed simply as "others". By means of a questionnaire particulars were obtained from all but two of these families as to their composition by sex and age and as to their expenditure on certain "fixed charges": rent and rates, lighting and heating, insurance and any regular payments to a doctor. The total sum thus accounted for was in each case deducted from income and the balance was compared with the amount of money needed to feed the family adequately at 1940 prices according to the British Medical Association standard. It was discovered that 51 out of 72 families which supplied full information on this point, that is, 71 per cent, would have had insufficient money to pay for an adequate diet even if all the remaining balance had been spent on food. Actually, when the purchase of other necessities is brought into the account, only 10 per cent of the families sampled had enough money left to purchase an adequate diet. Using an American rating scale of somewhat doubtful accuracy a further estimate was made to the effect that the diets of 40 families out of 53 tested were less than 50 per cent adequate. The report itself gives tables, but the above are the broad conclusions.

Detailed records of their expenditure were kept for periods of one to three weeks by 76 families. Analysis of these budgets revealed that rather more than one half of the families sampled over-spent their income each week. This is on the perhaps doubtful assumption that all sources of income were disclosed to the investigators. Some ran up bills, paying a little off as they could and the debt growing bigger each week; others, in particular those with a member of the family in the Forces, received help from relatives.

In the majority of families the proportion of income spent on non-essentials was very small, but it increased as the income rose. Expenditure on necessities other than food included relatively large

*Children's Nutrition Council, 37 Esslemont Road, Edinburgh, 28 pp., 3*d*.

instalments towards the hire-purchase of clothes and furniture. The temptation to buy wardrobes is said to be strong on account of the lack of proper provision for hanging clothes in houses put up under recent schemes. One instance is quoted of instalments paid by the same family on three wardrobes in two years: two were removed owing to failure to continue the weekly payments. About three out of every four families investigated also paid regular premiums to meet the cost of burial, in some cases amounting to more than 7*s*. a week. This is a serious drain on slender resources—enough to "pay for a funeral every year".

Returning to the main theme of the inquiry, the writers suggest that, apart from education in regard to the value and preparation of different foods, much might be done to solve the diet deficiency problems raised in this study by a wide extension of communal feeding, of the national milk scheme, and of all social services relating to food.

USE OF GLASSES AS AN AID TO VISION

By R. Weatherall
Eton College

As part of an investigation to discover whether physical defects among children increase with age, M. V. Marshall organized a survey of the use of glasses by children attending school in a representative American city.[1] In all, the survey covers 8,204 children ranging in age from kindergarten to the twelfth grade; that is, 5–17 years. The results show an almost uninterrupted increase in the use of glasses, from 2·7 per cent among the youngest, to 15·7 per cent around the age of twelve, and 23·7 per cent by the time the pupils are leaving school. An additional proportion of the children, ranging between 2 per cent and 7·5 per cent, had been advised to wear glasses, but were not doing so.

Children do not take kindly to wearing glasses when they first begin to take an active part in school games, and when they become conscious of their own personal appearance. Allowing for such personal factors, there are unexplained checks in the use of glasses around the ages of ten and fifteen. Also, personal factors alone can scarcely explain the wide discrepancy in the separate figures for boys and girls. Between the ages of twelve and seventeen the proportion of boys wearing glasses varies irregularly between 12 and 18 per cent, while for the same age-groups the girls show an increase from 17·7 to 32·8 per cent.

Altogether, the figures are striking enough. They show clearly that the need for glasses increases rapidly during a pupil's school life, so that by the age of sixteen about 1 in 7 of the boys, and 1 in 3 of the girls, are using artificial aids to vision. Even so, it is very probable that a still higher proportion of these children must be considered as having eyesight below normal. The figures revealed by this survey agree fairly well with those obtained by a smaller one which I carried out on boys attending a school in England. They give some measure of the magnitude of the problem of defective eyesight at the present time.

[1] *School and Society*, 53, No. 1375 (1941).

FATIGUE TESTS OF WELDED JOINTS

The publication by the University of Illinois Engineering Experiment Station of the results and conclusions derived from an investigation carried out there on welded joints in structural steel plates is but the first instalment or progress report of the proceedings*.

The primary object of those responsible was to obtain reliable information on which to base specifications governing the design of welded structural members subjected to reversed or pulsating stresses. The lack of knowledge of the fatigue strength of welded joints has been the principal deterrent to their adoption in the fabrication of bridges, and it was clear that tests on the largest practicable scale would have to be made before this method of construction could be placed on a satisfactory and reliable basis. Realizing this, the Welding Research Committee of the Engineering Foundation organized a special committee representative of all engineering interests to plan and carry out the work.

As used in this report, the term fatigue strength of a member refers to the maximum stress in the stress cycle which caused its failure at a stated number of cycles when the ratio of the minimum to the maximum stress had a stated value. While it is not possible to specify the stress which will cause failure at a predetermined number of cycles, it was practicable to estimate the stress cycle which would disrupt the specimen at the desired stage in the test. This was the procedure adopted and three kinds of cycle were used: (1) from a tensile stress to an equal compressive stress; (2) from zero stress to a maximum tensile stress; (3) from a maximum tensile stress to a minimum tensile stress of half the value. These gave ratios r, of -1, 0 and $+0{\cdot}5$ respectively, and for each value of r, seven identical specimens were tested: three so as to fail at 100,000 cycles, and three at 2,000,000 cycles, the seventh being a spare to be tested as desired after the other six tests had been completed.

* University of Illinois Engineering Experiment Station. Bulletin Series No. 327: Fatigue Tests of Welded Joints in Structural Steel Plates. By Wilbur M. Wilson, Walter H. Bruckner, John V. Coombe and Richard A. Wilde. Pp. 86. (Urbana, Ill.: University of Illinois Engineering Experiment Station, 1941.) 1 dollar.

In this way, four different investigations were carried out, namely, fatigue tests of butt welds in carbon-steel plates; comparisons of the strengths of welded and riveted joints in low-alloy steel plates; the effect of periods of rest upon fatigue strength of butt welds; and the influence of transverse fillet welds upon fatigue strength. Tests were made of specimens in the as-welded condition and of others with the reinforcement planed flush with the plate and of others again with it ground flush. In each category there were specimens which were stress-relieved by being heated to 1,200° F. for one hour and then cooled in the furnace while others were not stress-relieved.

Considering that the welds under test may be fairly regarded as having been made under as nearly as possible ideal conditions, the results indicate that when suitable allowance is made for variations in quality, the dependable strength of welded joints and plates weakened by transverse welds is still quite moderate. The details are too numerous to summarize, but as examples, some of the results at 2,000,000 cycles may be cited. Butt welds in ⅞-in. carbon-steel plates in the as-welded condition gave 14,400, 22,500 and 36,900 lb. per sq. inch in the three classes of cycle. The corresponding figures for machined-off specimens of classes 2 and 3 were 28,400 and 43,700 and for ground-off specimens of class 2 were 26,300. Stress-relief did not appear to affect fatigue strength, and periods of rest showed no advantage. Carbon-steel plates with one transverse fillet weld gave an average of 18,900 and with two welds 13,100 lb. per sq. in. The character of the bead had some effect on the figures, but for a given base metal the variation did not exceed 5 per cent.

FORTHCOMING EVENTS

Saturday, August 30

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Federation of British Industries, 21 Tothill Street, London, S.W.1), at 3.15 p.m.—Mr. G. A. V. Sowter: "Applications of High Permeability Magnetic Alloys to Electronic Devices".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTRICT EDUCATION OFFICER (man or woman)—The County Education Officer, County Hall, Hertford (September 6).

PUBLIC ANALYST and an OFFICIAL AGRICULTURAL ANALYST—The Clerk of the Berkshire County Council, Shire Hall, Reading (September 9).

LIBRARIAN—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (September 10).

CONSULTANT PSYCHIATRIST and an EDUCATIONAL PSYCHOLOGIST—The Director of Education, Education Office, Chapel Street, Salford 3 (September 13).

COLLEGE LIBRARIAN (woman)—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 13).

POWER STATION SUPERINTENDENT—The Town Clerk, Town Hall, Halifax (September 15).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Woolwich, London, S.E.18 (endorsed 'Appointment of Borough Electrical Engineer') (September 15).

LECTURER IN BOTANY, with subsidiary Zoology—The Principal, Technical College, Kingston-upon-Thames.

LECTURER IN ELECTRICAL ENGINEERING—The Principal and Organizer of Further Education in Rugby, College of Technology and Arts, Rugby.

POST-GRADUATE TEACHING SCHOLAR (Experimental Zoologist) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, The University, Edmund Street, Birmingham 3.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Marine Biological Association. Annual Report, 1939–40. Pp. 32. Annual Report, 1940–41. Pp. 32. (Millport: The Marine Station.) [118

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Tin Through the Ages: in Arts, Crafts and Industry; Handbook to a Temporary Exhibition, July–December 1941. By Dr. F. J. North. Pp. 38. (Cardiff: National Museum of Wales.) 3*d*. [118

Ministry of Agriculture and Fisheries. "Growmore" Bulletin No. 3: Preserves from the Garden. By B. Alice Craig and Margery Mason. Revised edition. Pp. 28. (London: H.M. Stationery Office.) 4*d*. net. [118

Experiment and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Twenty-sixth Annual Report, 1940. Pp. 72. (Cheshunt: Nursery and Market Garden Industries Development Society, Ltd.) [118

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 12, No. 2, September 1940. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+75–146. 4*s*. 6*d*. net. Vol. 12, No. 3, December 1940. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+147–226. 4*s*. 6*d*. net. (London: H.M. Stationery Office.) [128

Canteen Catering. Prepared and issued by the Ministry of Food. Pp. 84. (London: Ministry of Food.) 6*d*. [148

Other Countries

Memoirs of the Geological Survey of India. Vol. 74, Part 1: The Cretaceous and Associated Rocks of Burma. By Dr. E. L. G. Clegg. Pp. iii+102+xx. (Calcutta: Geological Survey of India.) 2.4 rupees; 3*s*. 9*d*. [68

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Ministry of Agriculture: Central Agricultural Research Institute, Sofia, Bulgaria. Polyploidy and its Role in Evolution and Plant Breeding. By Dontcho Kostoff. Pp. 85. (Sofia: Central Agricultural Research Institute.) [128

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NATURE

SATURDAY SEPT. 6, 1941

ANGLO-AMERICAN TECHNICAL CO-OPERATION

THE broadsheet, "America and Britain", which has recently been issued by Political and Economic Planning (P E P) directs attention to some of those technical aspects of co-operation between Great Britain and the United States, which are as important for the implementing of common policy and the achievement of common purposes as the great traditions and ideals on which Anglo-American co-operation is ultimately based.

Although the vivid realization of common danger and the need for joint measures against it has provided a stimulus to Anglo-American co-operation, it is not the only one. Already the question of dealing with food surpluses and their relation to European needs after the War has been responsible for joint planning and co-operation. The United States is vitally interested in the work of both the Leith-Ross Committee and the Willingdon Commission, and the agreements with the Governments of Australia and New Zealand on the disposal of their surplus food production recently announced by Mr. Arthur Greenwood are part of a great scheme of international reconstruction, the success of which depends on common action with the United States and with the Latin American republics.

Developments in this sphere providing the means by which the United States can, in accordance with President Roosevelt's pledge of March 15, play its great part in the period of world reconstruction for the good of humanity, cannot but have a profound bearing on the problem of the formal organization of Anglo-American co-operation which is the theme of Mr. Streit's "Union with Britain Now". Indeed they may well provide the experience upon which any federation proposals can be most securely based, and seen from one angle represent experiments in keeping with the traditions of both democracies from which new methods can be most surely developed.

There are other fields also in which this experience is being gained. A notable article by Prof. A. V. Hill in *The Times* has described the way in which organization is being developed for an effective Anglo-American partnership in research. Already last summer, as a result of an approach by Lord Lothian, President Roosevelt invited the British Government to send a mission to the United States to consider ways and means of sharing scientific and technical information between the United States Services and the National Defense Research Committee on one side and the British Services and scientific organizations on the other.

The very satisfactory arrangements ultimately made as the outcome of Sir Henry Tizard's mission have played an important part in creating good will and enlisting the co-operation of American men of science, and the liaison now established will become increasingly important as the Lease-Lend Act operates.

The possibilities of co-operation in this way are as yet barely realized by the majority of scientific workers, and whether in research or the supply of skilled personnel, collaboration between British and American men of science offers immense advantages to both countries, in peace as well as in time of war. The advantage to the United States of British experience in war research and in operations against the enemy should be as obvious as is that of the vast scientific and technical resources of the United States to Great Britain. What is less apparent is that the increasing dependence on American supplies to which the Lease-Lend Act commits us implies in the long run the acceptance of United States patterns, often adapted from Allied types, or in the light of Allied experience, as the basis of the army and air force equipment of all the forces using American supplies.

An understanding between the United States and the British Commonwealth on the standardization of equipment is accordingly essential, with agreement as to the best form of mechanisms and devices of warfare. This, with the establishment of rapid transport both ways for essential information, experimental equipment and key personnel is one of the most important immediate objectives on the scientific and technical side. Following this might come some agreement as to the location of research on different types of problem, the more immediate problems being tackled in Great Britain, the longer-range problems in the United States, for example.

The many able men and women attracted to Washington by the New Deal provide the United States with an invaluable source of staff for the war-time organizations, and the strengthening of the United States Civil Service in the last ten years has also been a major factor in enabling the administration to deal with its new tasks. As is increasingly recognized in Great Britain, even more important than the new powers and new machinery of government is the way in which they are used. This is primarily a question of personnel, and there is little doubt that both countries could profit by use of the other's experience in such fields as labour policy, the handling of man-power, and all questions of priority, both in respect of man-power and materials. Co-operation indeed in this field offers the only prospect of obtaining the full efficiency involved in maintaining the proper balance between the British armed forces and the overseas workers. The former can only be maintained at its level of nearly four millions because the United States and the Dominions provide its supplies. The establishment in London and Washington of a common research organization to consider the economics of the British Empire and the United States in this way might be a useful practical recognition of such unity and powerfully assist the elimination of bottle-necks.

Even in a country as wealthy as the United States, some shortages are bound to occur—probably with non-ferrous metals such as manganese and chromium and the special steels—and some rationing of raw materials on the British model may be required, with a thorough discard of the idea that monetary means can secure smooth and rapid production for war. Already it is recognized that some restriction of consumption so as to divert output from the non-essential industries to war production is necessary in the United States as in Great Britain, and the whole field of war economy offers possibilities of pooling experience that should promote co-operation and understanding for peace purposes as well as for those of war.

This is notably true in certain special fields such as those of food policy and social security, to which particular attention is directed in the P E P broadsheet. It was increasingly recognized before the War, on both sides of the Atlantic, that the provision of a minimum diet and standard of life ought to be a first charge upon the national income. The supply of milk to all children in schools and junior instruction centres in Great Britain under the Milk Act of 1934 has been followed by war-time measures designed to prevent the fall in food standards from affecting the diets of poorer people. The American Food Stamp plan was an ambitious experiment with the same end in view of increasing the consumption of the protective foods, dairy products and fruit, of which the poor consume so much less than the richer classes.

Wide adoption of certain of the measures, such as school feeding, introduced in Great Britain, might effectively raise the low dietary standards in some parts of, and among certain classes in, the United States. Moreover, as Mr. Winant emphasized in his valedictory report to the International Labour Organisation, war increases the need for social services to cushion the shock of reductions in consumption and drastic changes in popular modes of life. The creation in peace-time of a comprehensive system of social security services is a great asset both to Great Britain and the United States, and one of the really solid achievements of the New Deal has been the application of the principles of British social legislation in a thorough and promising way.

The importance of developments in this field, notwithstanding the controversy persisting on both sides of the Atlantic on the administrative and financial problems involved, should not be overlooked. The extension of the unemployment and health insurance schemes in Britain, for example, removes one of the causes of lower middle-class insecurity which in Germany contributed to the rise to power of the Nazis, and may also facilitate a new social and political solidarity apart from its contribution to the establishment of the third freedom of President Roosevelt's speeches. Beyond this, the compromises which have been reached at different points reflecting the different balance of forces in the two communities cannot disguise the common pattern leading up to and flowing from every new social measure in Great Britain and the United States.

Many of the developments which have taken place on both sides of the Atlantic are scarcely more than improvisations to deal with urgent needs. This is notably true of education, where neither of the two great democracies has an entirely satisfactory record. In both countries, however, there have been developments, such as the country schools established as a result of evacuation in Great Britain, and the Civilian Conservation Corps in the United States, which hold great promise for the future integration of town and country and afford opportunities for pooling experience and for the growth of mutual understanding.

These wide fields over which Anglo-American co-operation is already proceeding, and the immense range of common experience, are a powerful reason against hastily forcing the organization of formal co-operation into any set mould or union. That effort should be deliberately directed to the examination of the possibilities and the testing of alternatives is all to the good, but the utmost care should be taken to avoid any step which might impede rather than promote effective collaboration. For this reason with such investigation a nation-wide campaign of education should proceed even in the stress of war, supplementing the brilliant efforts of leaders on both sides of the Atlantic, to interpret and understand the differing interests and points of view of the two peoples as well as their common ideals, traditions and heritage. Even the domestic post-war reconstruction plans in Great Britain under the Ministry of Works and Buildings and the Cabinet Committee on Reconstruction and War Aims are being followed with keen interest in the United States, where the resolution before the Senate proposing the establishment of a "Post-Emergency Economic Advisory Commission" to plan for full employment indicates that people in the United States are also beginning to think and plan in response to the same challenge.

If there is interest in questions of domestic reconstruction, this is even more true in international planning, where many thorny questions will require much thought and careful consideration. The visits of leading British citizens to the United States and the dispatch of American missions to Britain on such varied questions as economic mobilization, scientific co-operation, health services, A.R.P. and fire-watching may help to cross-fertilize opinion and prepare the ground for what must be comprehensive plans. The presence of many European refugees in both countries and such developments as the transference of the headquarters of certain international trade unions to Britain, and the recent conference of representatives of Allied Governments in London should also assist in the formulation of sound proposals for European reconstruction.

The Eighth American Science Congress in May 1940 favoured an inventory of world natural resources and the formulation of a general policy and specific programme of action to promote mutual conservation and prudent utilization of natural resources for the welfare of all nations in the interest of permanent peace. The report of a round-table conference in February at Princeton, New Jersey, under the auspices of *Fortune*, indicates that influential American opinion already recognizes that American help is essential to eliminate the growing burdens of an armament economy. The majority favoured the acceptance of commitments on behalf of a New Order of Free Peoples resting on recognition by the State of the unique value of human personality, restriction of national sovereignty, and creation of effective international institutions.

The report went on to outline a programme of war-time co-ordination, including the formation of an Anglo-American Technical Board to work out common specifications, the creation of a United States Department of Economic Defense, and joint purchase and storage of raw materials by the two Governments, the gradual creation of an Anglo-American Economic Council, and the appointment of an official commission to prepare a programme of post-war demobilization. The problems of the latter period are considered at length, and suggestions advanced for American contributions to the restoration of a world economy include the continuance of the low tariff policy and the resumption of foreign lending on behalf of a general reconstruction policy.

Whatever form the organization of the new order of free peoples may take, this report suggests that the United States should at least participate in machinery for the settlement of international disputes and in a system of effective sanctions against aggressors, accept the responsibilities of a creditor

nation, conclude agreements regulating domestic policies that might injure other peoples, and participate in agreements for the reduction of armaments. This is weighty evidence of American support for the Atlantic Charter.

Both in Britain and in the United States scientific workers were among the first to realize the true nature of the Nazi menace and its attack on freedom of thought and investigation. They will appreciate the enduring values which community of tradition and doctrine give to the Anglo-American co-operation now so rapidly developing. They will not be the less zealous in their efforts to evolve in scientific and technical matters the machinery of effective co-operation, and to assist in the educational work which makes for understanding between the two communities for this growing evidence of some greater and more enduring co-operation after the War, in the tremendous task of establishing a world order to serve more abundantly man's noblest heritage and highest aspirations as well as his material needs.

A JERSEYMAN AT OXFORD

A Jerseyman at Oxford
By Robert Ranulph Marett. Pp. xi+346+4 plates. (London, New York and Toronto: Oxford University Press, 1941.) 15*s.* net.

TO-DAY it is increasingly the custom among men and women, if they count themselves to have done or seen something, to write their autobiographies, and honesty compels the critic to own that they are seldom successful. But this book is an outstanding exception. Here is a man who has "warmed both hands beside the fire of life", and in his seventy-fifth year that fire has not yet shrunk. He writes with zest and gusto *currente calamo* out of the fullness of a mind produced not only by reading and disciplined study, but also by knowledge of many friends and many countries, together with many and varied experiences such as come to a man who prefers the struggle to the prize, and can throw himself wholly into what he happens to be doing.

Dr. Marett in comparison with the vast majority of his fellow-countrymen, as he would himself be first to confess, has been a fortunate man from the start. Born of good family, reaching back through many generations of service in Jersey, he was brought up in a good home with wise and cultured parents in a beautiful place set fair in the freedom of sky and sea. Nature in her kindness endowed him with good brains, good memory, lively imagination and abounding physical vigour. He has been excellent in games which have interested him, particularly golf: he has been, and is, a good shot. Eyesight, strength and nerve have not failed him in more than seventy years. When as a young man just down from Oxford he was free to travel abroad, he enjoyed long spells in France, Germany and Italy. If Paris and an aristocratic home, poor but proud, bored him, in Germany he was able to move in the Junker set, to dine once in the Kaiser's presence, to frequent the universities, and to be adopted by the American colony. In Italy he was under the patronage of Lord and Lady Dufferin, and all doors were open to him. Antiquities, pictures, the best company, rides over the Campagna, Rome, Naples, Sorrento —"a rapturous year" he rightly calls it. And what a mixture of interesting people for a young man to meet—Lord Dufferin and Lord Hartington, Lanciani and Dr. Axel Munthe, Buffalo Bill and Prince Napoleon Bonaparte, even King Umberto and the Pope himself—the last in compromising circumstances. Some will pretend to look down on this sort of thing, but these advantages are very real for a young man who knows how to mix, and does not allow his head to be turned.

Not only has he been fortunate, but also lucky: in the lottery of life luck counts too. Lucky, when as a child of eight he was rescued from his burning house, lucky when on the Riffel Alp he fell off a cliff into a dead pine-tree which held, and on the Langdale Pikes off a crag forty feet into soft snow; lucky again when, feeling ill in Oxford, he pulled by chance the door-bell of a doctor who could diagnose meningitis at sight, lucky in the last war when in a black-out he fell between a moving train and the platform, and escaped hurt, but not maimed, and twice when he came very near to German bombs; lucky when but the other day he received thirty-seven pellets at close range in his leg, and did not lose it. In all these cases the dice might so easily have fallen otherwise.

This book begins rightly with his island, his ancestors and his home: there emerges the picture of a boy with sport in his blood, but sport going along with natural history. A good preparatory school, and Victoria College in a good period follow, the picture now of a boy picking up classics without taking too much trouble. A Balliol Exhibition is won, Benjamin Jowett enters his life, he becomes in his own words a "smug", or "a natural extrovert imposing upon himself an

introverted character by sheer will". A strange type of introvert, who made hosts of friends, became secretary of the Union, and belonged to eighteen societies. By dint of reading by the light of nature he got a first in Mods. and the Chancellor's Latin Verse. A whole chapter is rightly given to Greats, for it made him finally what he is: Jowett and Lewis Nettleship between them made him a Platonist, and Strachan-Davidson set him to read "Custom and Myth". In spite of meningitis he got his first for his brilliant promise, and passed on to his *Wanderjahre*, then a year as maid of all work at Balliol, and finally his Exeter fellowship. The interest of autobiography lies not in telling what a man is, which in this case all the world knows, but how he came to be what he is. Exeter has been his life since: he has held all offices there, and is now its rector, unanimously elected, unanimously prorogued to the full limit. In this book the whole of his wonderfully interesting activities is written at length. For two-thirds of his time he has taught philosophy, in the remaining third he has made a world-wide name in anthropology; but whether he has done his more valuable work as a famous pioneer in a new science, or in the quiet guidance and shaping of the minds of successive generations of young men is unknown to him, as to all.

Here at the very end fortune has proved adverse. Almost in the same hour he lost his eldest son in the *Glorious*, and his home and all his possessions in Jersey. It shows what manner of man he is that he has in bereavement and loss written this delightful book, full of happiness, crowded with interest, and without one unkind word spoken of any—the splendid record of one who through a long life has set himself "to strive, to seek, to find and not to yield". CYRIL NORWOOD.

DEVELOPMENT OF MATHEMATICS IN THE UNITED STATES

(1) A Semicentennial History of the American Mathematical Society, 1888–1938

With Biographies and Bibliographies of the Past Presidents. By Raymond Clare Archibald. Vol. 1: History. Pp. x+262. Vol. 2: Addresses. Pp. v+315. (New York: American Mathematical Society, 1938.)

(2) Bibliography of Mathematical Works printed in America through 1850

By Louis C. Karpinski. Pp. xxvi+697. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1940.) 33*s*. 6*d*. net.

(1) THE American Mathematical Society anticipated its semicentenary, which fell in 1938, by appointing a celebration committee ten years in advance of that date. The semicentenary was a great social event; it was also the occasion for the issue of two handsome volumes, a history of the Society and a set of addresses.

In Prof. Archibald's history, a detailed account of the birth and growth of the Society is followed by biographies and bibliographies of the secretaries and the presidents. The early chapters describe an amazing advance, of which the character is revealed most clearly in abortive negotiations with the *American Journal of Mathematics* which preceded the establishment in 1900 of the *Transactions* of the Society. To the older men, America was an intellectual dependency of Europe, and the ambition of an American journal was to attract contributions from the great scholars of the Old World; a younger generation was confident of its native powers. A stroke of diplomatic genius on the part of Maxime Bôcher drew the sting from the dispute, no resentment remained, and when in 1925 the great depression threatened the existence of the *Journal*, the Society came willingly to the rescue.

Written before 1939, the story of the struggle to maintain international collaboration in mathematics makes heart-rending reading to-day. We must derive what comfort we can from knowing that it was a story of Anglo-American co-operation, for the London Mathematical Society, in our more intoxicated country, was a partner with the American Mathematical Society in protest against the blind French vindictiveness which organized an allied congress at Strasbourg in 1920 and would have excluded Germans from Bologna so late as 1928 if the committee arranging the latter congress had not defied the ban. But success too long delayed is illusory. "You shall not come" of 1920 and 1924 became "We will not come" in 1936. It is only in the most formal sense that Prof. Archibald's assertion that "No political taint marred the delights of the congress at Oslo" is to be interpreted. The Germans made no pretence at co-operating, the Russians decided at the last minute not to attend and rapid changes of programme became necessary in consequence, and the time of

year was exceptionally inconvenient, we were given to understand, for the French. The Congress was international in constitution, and its delights were truly unmarred, but there were few beside Americans, British and Swiss to share the unmarred delights with their Scandinavian hosts. In all but name the series of international congresses which began at Zurich in 1897 came to an end there in 1932, for the epilogue of Oslo in 1936 was less in the spirit that inspired the early meetings than was the prologue of Chicago in 1893.

Prof. Archibald's story of the rise of the American Mathematical Society is a model of exact information attractively presented. He was fortunate in the completeness with which records had been kept; with the best will in the world, few historians can hope to imitate him. More remarkable as a personal achievement is the compilation of biographies. Regarding men of the standing of G. W. Hill and Simon Newcomb, Oswald Veblen and G. D. Birkhoff, sources are plentiful and the biographer's task is selection and composition; bibliography always presents countless little problems, but these are meat and drink to Prof. Archibald. Where his passion for accuracy and completeness has found full scope is in the reconstruction of the characters and doings of the less distinguished of his subjects; there are no gaps in his series, and even his collection of photographs is complete.

Enjoyment of an art is one of the good things of life. If ignorant and facile it cannot be rated highly, but if it is informed, critical and appreciative it is the very stuff of which civilization is made. It is not to be measured by creative ability; to react to the subtle cadences and alliterations of great prose is better than to feel smug satisfaction in composing a scrap of doggerel. If the artist covets the praise of his peers, that is because their judgment involves an understanding of technical success, not because it is they only whose receptive emotion is worth arousing. Perhaps no one has seriously maintained that poetry should be read only by poets, ballet watched only by choreographers. The view that higher mathematics has no contemplative side but exists only for its practitioners may be less demonstrably absurd, but it is certainly ungrateful. For the past hundred years, the societies through which mathematicians have reached a public outside their own lecture-rooms have been utterly dependent on the support of long-forgotten members who have no place in the history of mathematics and who asked in their time nothing more than to promote the study of mathematics and to facilitate the work of mathematicians. From London and Palermo to New York and Madras the story is the same, not of a few great men supplying each other's needs, not of braggart mediocrities indulging in mutual admiration, but of sincere and modest enthusiasts. Prof. Archibald has conferred on the devoted servants of the American Mathematical Society that measure of survival to which they are entitled, and in doing so he has not attempted to exaggerate their importance as mathematicians. It must be confessed that in one sense his own kindly disposition and his familiarity with almost all the men of whom he writes have disqualified Prof. Archibald: he is not the impartial biographer, recording faults and foibles as well as merits and achievements; we cannot learn from everybody's friend that this man was vindictive, that man conceited, and a third an amiable but inflexible dictator. But mathematicians are as liable as other people to disagreeable traits, and when the nearest approach to censure in twenty-six sketches is in the quotation "For the apparent eccentricities of his private life there must have been some sound reason, creditable to him", we know that only one aspect of each sitter is being drawn. None the less, the portraits that emerge are differentiated and vivid.

Before we turn from this volume we must make mention of the preface, where all that is most likeable in Prof. Archibald and most admirable in his work finds uncalculated expression.

Of the volume of addresses little can be said unless each address is to have its own notice. The contributions are as follows: E. T. Bell: fifty years of algebra in America; J. F. Ritt: algebraic aspects of the theory of differential equations; N. Wiener: the historical background of harmonic analysis; E. J. McShane: recent developments in the calculus of variations; T. Y. Thomas: recent trends in geometry; R. L. Wilder: the sphere in topology; G. C. Evans: Dirichlet problems; J. L. Synge: hydrodynamical stability; G. D. Birkhoff: fifty years of American mathematics. The nine addresses all tell the same astonishing story of progress; in the first and last we follow it step by step; in the others we join the leaders in the forefront of their advance. The country which, if Hill and Newcomb must be ceded to the astronomers and Gibbs to the chemists, had produced by 1888 only one mathematician, Benjamin Peirce, had become in 1938 the equal of any country in the world, and is ready, if European civilization in its collapse buries England in the ruins, to fulfil alone the task of preserving and enriching the human heritage. The transformation was not the work of one man, but our historians agree that in the first twenty years of their half-century there was one dominating influence, that of E. H. Moore, of whom Prof. Bell says that his interests frequently changed, and with each change, mathematics in America advanced. Moore lived

to see the time when young European mathematicians were as ready to travel for inspiration to Princeton as to Paris or Vienna.

(2) The condition of mathematics in America forty years before the foundation of the American Mathematical Society is to be inferred from Prof. Karpinski's bibliography of American-printed mathematics 'through 1850', to use the convenient new idiom. In this exhaustive and handsome volume, in the preparation of which Prof. Karpinski has been helped by booklovers and librarians up and down the continent, some three thousand items are listed, and there are 908 photostatic reproductions, chiefly of title-pages. Prof. Karpinski could have spared himself much trouble by following the example of D. E. Smith's "Rara Arithmetica" and referring to figures when they are given instead of transcribing titles in these cases. It is not for the reader to complain except on the ground that there might then have been more annotations, and like all expert bibliographies this one perpetually arouses curiosity. What, for example, was the general solution to an algebraic equation which Jason H. Mahan published in 1847 under the title "Key to the Hitherto Impenetrable Secret"? Why does Prof. Karpinski assert that Hobart's "Mathematics Simplified and made Attractive, or the Laws of Motion Explained" is "doubtless a second edition" of an unlocated book which according to its copyright entry-title was "designed to shorten and make plain and easy nearly all the rules which are usually put into arithmetic"? Was Mark Duty a blind man?

In 1909 a story was current in Cambridge that a scholar of Trinity had attended the first lecture of Russell's announced course on the principles of mathematics in the belief that he was being offered intensive coaching for the impending Tripos; this story comes to mind when one finds Chittenden's edition of Motte's translation of the "Principia", which incidentally is one of the most eccentrically paged books ever printed, indexed under "General Works on Mathematics". The transcription of the title of this volume, on p. 491, illustrates how much hangs on accuracy in type, for no one without previous knowledge could interpret 'Newton's system of the world' correctly. Consistency may be the supreme bibliographical virtue, but should any rule be held proof against the exception in which the authors' names appear thus: "Todd, John, Jess, Zachariah, Waring, William, and Paul, Jeremiah"?

A few samples must be taken. The publisher who issued a primary arithmetic under the title "Hints to Mothers" not only provides evidence of the thoroughness with which Prof. Karpinski has done his work but also gives complete revenge to a famous if fabulous young coleopterist. Zerah Colburn—I take the story from De Morgan's "Budget"—pestered to explain his mode of instantaneous calculation, cried out in a huff "God put it into my head, and I can't put it into yours", but R. L. McLallen was not afraid to bring out in 1844 "A new and interesting Arithmetic, in which is explained the method that Zerah Colburn must have pursued". The word 'kindergarten' was as yet unnaturalized when the 'Chinese trangram', issued anonymously in 1817, suggested to Thomas Hill the "Puzzles to Teach Geometry" which appeared in 1848 with an approving letter from Peirce. In 1840 Peirce's interest in education took the practical and beneficent form of "An Elementary Treatise on Plane Geometry . . . printed for the use of the Blind"; we are not told whether the contents were conventional or if Peirce endeavoured to take into account the effect of blindness on the sense of form. A year later the Asylum Press followed this geometry with a table of logarithms, also printed on raised plates.

Enough has been said to show that Prof. Karpinski's bibliography is comprehensive as well as fascinating. In his very readable introduction he says: "My search, and particularly the check upon it given by various early lists, inclines me to venture the prediction that not fifty new titles which are strictly mathematical will come to light within ten years." In short, an ambitious plan has been well accomplished. The volume is indexed liberally, and an index of printers and publishers is specially to be welcomed, though there, alas, the insidious 'Pierce' is to be found.

When we look into Prof. Karpinski's bibliography not for entertainment but for evidence, when we ask the quality not of the record made but of the material recorded, what do we find? We find a devastating tale of trivialities, relieved only by translations of the "Principia" and the "Mécanique Céleste", to which, if we are generously disposed, we may add a score of minor undergraduate textbooks. We can speak with mathematical respect of the arithmetics produced in Mexico and Peru in the century and a half before 1703, the year of the first entry in English, but not of the hundreds of arithmetics that form, with surveyors' manuals, books on mensuration, sets of tables, and a few schoolbooks on algebra and geometry, American 'mathematics' until less than a century ago. North American civilization is coeval with that of Western Europe, and North America was colonized not by scourings and failures but by men of enterprise, intelligence and boundless energy. The ecological lesson is clear and menacing: the flowers of civilization flourish only in a garden, not on the fringe of a wilderness, against the walls of a factory, or in a corner of a battle-field.

E. H. NEVILLE.

THE RELATIONS BETWEEN SCIENCE AND ETHICS

By Dr. C. H. Waddington
Christ's College, Cambridge

THROUGHOUT most of history, man's concept of the Good has been rightly considered to have, or at any rate to require, a philosophical justification; that is to say, a justification dependent on the characteristics, not of a particular individual, or group of individuals, but of the world in general. This might be deduced from observation, as in the theory of Utilitarianism, or revealed by the voice of God or of conscience. During the last quarter of a century, four lines of thought have converged in an attack on this notion, and their combined effect has apparently gone far, at least among what may be called 'popular intellectual' circles, to rob ethical statements of any claims to intellectual validity. All four of these trains of thought had their origin in scientific movements. They were:

(1) The psycho-analytical, based on an examination of individual psychology, which seemed to imply that man's ethical system is a mere product of his early sexual reactions to family life, and has no more generality than that has.

(2) The anthropological, based on a comparative study of social systems, which tended to show that ethical beliefs differ extremely from culture to culture and can therefore have no general validity.

(3) The Marxist, primarily based on a study of the changing society of Western Europe, which appeared to assert that ethical systems are expressions of class forces and are epiphenomena which may be left out of account when we are considering the mechanism of social development.

(4) The anti-metaphysical of the Logical Positivists, based on the attempt to realize the 'unity of science' through a study of meaning, and issuing in the view that ethical statements have no meaning of a verifiable nature.

None of these summary statements of the four arguments is, I think, an entirely fair account of the contribution which the science in question has made to the study of ethics. But they do represent not too inadequately the sense in which these contributions have been understood among wide circles of the general reading public, including many of the younger men of science. Taken together, the four lines of attack were undoubtedly successful in persuading many people that science either has nothing to do with the formulation of ethical systems, or even is necessarily inimical to any such attempt. I wish to argue here the contrary thesis: That if these four contributions are correctly interpreted, ethical judgments are statements of the same kind—having, as the logisticians would say, the same grammatical structure—as scientific statements. I shall deny Carnap's argument that the typical ethical statement 'killing is evil' is merely a paraphrase of the command 'do not kill'[1], and "does not assert anything, and cannot be proved or disproved". I shall argue that an ethical judgment is better typified by a statement such as "You are an animal of such a kind that you must consume 7 mgm. of vitamin C per diem, and should consume 100 mgm.", that is to say, by a statement which has scientific significance.

An ethical belief must be believed by someone; and the psycho-analytical discoveries, which are concerned with the development of the ethical systems of individuals, are the most profitable basis from which to begin an examination of the scientific basis of ethics. Psycho-analytical literature is voluminous, and is couched in a somewhat anthropomorphic jargon which, while it may be an inevitable result of attempting to write in conscious language of mental processes which do not occur within consciousness, is undoubtedly not very perspicuous for the layman. But one may, with all due diffidence, mention two points which seem to emerge from it.

In the first place, ethics appears among psycho-analytical phenomena as the consciously formulated part of a much larger system of compulsions and prohibitions. Many of these remain permanently below the level of consciousness, but, all together, they make up a more or less isolable dynamic function within personality, known as the super-ego. By setting up the super-ego as the entity for investigation, psycho-analysts are abolishing, in a very radical way, the class distinctions which we commonly make among our inner compulsions, which lead us to hold that the prohibition on picking one's nose in public, for example, although often much stronger than that on lying, is less worthy of consideration. This is a piece of realism for which one can have nothing but gratitude. Moreover, it brings out clearly the very important point that one cannot avoid ethics; it is impossible to give them up like smoking in Lent. They are part of the super-ego, and the super-ego is inescapable among those present (accompanied by

the ego, the id, the ghosts of Œdipus, Narcissus and the rest) whenever we do anything.

The second of the psycho-analytical results which requires attention is more fundamental, but in some ways less straightforward. Put shortly and crudely, it is that the super-ego is formed as a result of experience of the material world, and that its propositional content has been verified in experience. There are two difficulties in the way of establishing this. First, the super-ego is being formed from the a of about six months onwards, and empirical observation at that time has a peculiar character which it later loses. "The baby", writes Joan Riviere, "cannot distinguish between me and not-me; his sensations are his world, *the* world to him."[2] The first crude notion of externality, of otherness, arises through the experience of an inability to control; and the objects which thus intrude into the baby's solipsistic day-dream are inevitably personalized, distinguished as "not-me but another person". More than that, they must appear to butt in from outside what had been thought of as all-embracing. It is, I suggest, because the development of ethics is connected with this break-up of solipsism that it has that character of other-worldliness, of absoluteness, which made plausible the anti-metaphysical comment that one can no more talk about it than about the ultimate reality behind the world's appearances. "Wovon man nicht sprechen kann, darüber muss man schweigen", said Wittgenstein in 1919, addressing philosophers[3]. His words would have been more apposite in the mouth of a mother talking to her child; but unfortunately one screams as though the devil were on one's tail; probably he is.

The second difficulty in establishing the dependence of the super-ego on experience arises in connexion with the distinction between the external and the internal, between the individual and his environment. There is first a simple confusion to clear out of the way. One finds, for example, the following sentence by Freud[4]: "Whereas the ego is essentially the representative of the external world, of reality, the super-ego stands in contrast to it as the representative of the internal world. . . ." But the context makes it quite clear that Freud is speaking here of the adult personality, at a time when the super-ego has already been formed. He is not, in calling that entity the representative at that time of the internal world, denying that at an earlier period, during its formation, it was dependent on the external world. In fact, in another place he states, fairly explicitly, the point which I wish to make: "The role which the super-ego undertakes later in life is at first played by an external power, parental authority. . . . This objective anxiety is the forerunner of the later moral anxiety."[5]

But the difficulty goes deeper than this. The author who has, perhaps, contributed most profoundly to our knowledge of the formation of the super-ego is Melanie Klein. Her view "lays emphasis on the importance of the impulses of the individual himself as a factor in the origin of his super-ego and on the fact that his super-ego is not identical with his real objects"[6]. But, she writes, "In thus regarding the impulses of the individual as the fundamental factor in the formation of the super-ego we do not deny the importance of the objects themselves for this process, but we view it in a different light." Now it may be pointed out that in emphasizing the importance of the external objects in the formation of the super-ego, the role of the innate impulses of the individual has not been denied. The question at issue is whether the ethical beliefs which form part of the super-ego are injected into the individual apart from and independently of his experience of the material world, or whether they are formed by the interaction of the personality and the world; there cannot be any question of the super-ego being impressed by external circumstances on to a merely receptive and featureless individual. The answer which I am urging is that the situation is actually parallel to that with which we are familiar in genetics; all characters are, as Goodrich put it, both inherited and acquired; they are products of the interaction between the genes, which we usually consider internal, and the equally necessary factors, such as oxygen, nourishment, etc., which we usually consider external. Strictly speaking, one cannot say that the propositions of ethics arise from experience of external, as opposed to internal, connexions; their origin is the observation that the world is such, and the personality is such, that the individual must follow certain rules.

Here, it may be urged, the word "must" in the last sentence may be going too far. Granted that the propositions of ethics are derived from experience, does that experience teach us more than techniques which lead to pleasurable results, and do we still need to invoke some non-experimental criterion to judge, not what gives us pleasure, but what *is* pleasurable or good and what bad? But if there were any such ulterior criterion, it would have to be of the most general and unspecific character. What we are considering is not the abstract entity 'ethics', but actual super-egos as they are effective in human personalities; and they are so variable from person to person, that, if their contents are taken to consist of rules for obtaining some ultimate objective, that objective must be of an extremely vague character. Further, there are many propositions for which it is clear that no ulterior criterion of value is necessary. The statement that it is as well not to put your hand in

the fire is not based on anything else except the fact that if you do it will cease to be a hand: and existence is its own justification; hands are the kind of things which do not go in fires. Self-destruction of an entity only comes into question when there also exists some large unit of which that entity is a part, and it only occurs when this more inclusive unit is more powerfully energized in the dynamic system of the super-ego.

According to some psycho-analysts, an urge towards self-destruction is, in actual fact, very early awoken in the young child. But there is obviously in existence an entity in which the child is only a part, namely society, and the facts which the child is learning and incorporating into its super-ego are very largely facts about the existence of society and his place in it. He discovers, for example, that if, in anger at being denied the maternal breast, he attempts to attack his mother, he is either restrained or at least disapproved of. That disapproval is ultimately based on nothing more than the existence of society, which would be impossible if aggression were uncontrolled. The child, of course, does not himself discover that the existence of the society of which he will be a member demands the control of aggression; that knowledge can only belong to his parents, and may not be formulated even in them. But the disapproval which the child experiences is a result, mediated either by intelligent knowledge or by the unconscious processes of natural selection, of the requirements of human society. The ethical principle 'Be good, sweet child!' derives what validity it has from social facts as real as the calorie quota for human survival.

During the very early months, when the main structure of the super-ego is being formed, the most important facts which come to the notice of the child are social facts, arising from its relations with its parents, nurse, etc. The anthropological discovery that systems of ethics differ in different cultures is therefore not only not surprising, but is indeed a necessary consequence, and a confirmation, of the view here put forward. The way in which these systems of social behaviour are conditions for the existence of the cultures concerned has been fully discussed by Malinowski and his followers. But we must, I think, go farther than this. Ethics, at this point in the argument, appears as a system of rules of action derived from the necessary conditions for the existence of society. They appear, that is to say, as simply conservative. It would be a sanguine man who would depreciate such a function at the present day, but we cannot in fact expect society to continue unaltered. A tendency to evolutionary or developmental change is a general characteristic of biological entities, including societies, and it is certainly true of Western European civilization that the ethical systems engendered within it are not simply conservative but are among the agents of this change.

The contribution which theoretical Marxism made to the study of ethics was actually not to debase ethics to the position of a mere epiphenomenon, but was a combination of this point with the anthropological argument mentioned above. The widespread misunderstanding of this is partly due to the very diverse, and sometimes regrettable, practical applications of the Marxist theses on ethics which have been made by various political parties; and partly to a certain naughty-boyishness, a roguish delight in paradox *pour épater les bourgeois*, in the Grand Old Men themselves. Such a spirit is perhaps not unexpected in professional revolutionaries, but it has led to some remarkable confusions when interpreted by the more earnest of the true believers.

Marx and Engels urged, first, that ethical ideas are derived from the experience of social facts. This part of their argument is one of the almost innumerable meanings of the famous phrase 'freedom is the knowledge of necessity', an epigrammatic statement the highly complex ambiguity of which should commend it to the school of poetic criticism represented by Mr. Empson. Further, they asserted that different social classes, encountering different material conditions, form different ethical systems. They also showed that the differing conditions of the social classes bring about developmental changes of the society as a whole. Since they, of course, acknowledge the fact that "all the driving forces of the actions of any individual person must pass through his brain, and transform themselves into motives of his will in order to set him into action"[7], this implies that it is only through the systems of beliefs to which they give rise that the social conditions are effective. The point was somewhat obscured by their insistence on what was the newest and most controversial aspect of their doctrine, namely, that the social facts from which the ethical systems are derived could be ultimately reduced entirely to matters of economics. And it was, as mentioned above, also concealed by some of their more irresponsible utterances; for example, by Engels: "it is precisely the wicked passions of man—greed and lust for power—which, since the emergence of class antagonisms, serve as levers of historical development"[8], in which he emphasizes the imperativeness of the socially determined Good by comparing it to unrestrained biological drives. But, in spite of the confusion caused by such verbal tricks, Marxism did provide the logical basis for the view that realist ethics can change society and not merely preserve it.

Having now reached the position of seeing a social system as something the existence of which essentially involves motion along an evolutionary path, we are confronted again with the question which was discussed five paragraphs above in terms of static existence: Do we need some external criterion to decide what is the 'good' direction of evolution, or is that implicit in the society? Again, I think, one can answer that no criterion external to the natural world is required. An existence which is essentially evolutionary is itself the justification for an evolution towards a more comprehensive existence; a society implies a direction of development into a society which could include the earlier stage, as, to take an exaggerated example, American culture can include that of the Red Indian, but not vice versa. One can put the same thing in another way by reference to the history of evolution; on the whole, the later products of animal evolution have capacities which include and transcend those of their ancestors.

But, it may be said, granted that the existence of a society does imply a direction of change, why should that direction be accepted as good? One could quote eminent authority against such a view. "Let us understand, once for all," wrote T. H. Huxley[9], "that the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it." But he was writing under the spell of that extraordinary impulsion, so incomprehensible to us to-day, which forced the Victorians to transmute the simple mathematics of their major contribution to theoretical biology into a battle-ground for their sadism. To Huxley, the cosmic process was summed up in its method; and its method was "the gladiatorial theory of existence" in which "the strongest, the most self-assertive tend to tread down the weaker", it demanded "ruthless self-assertion", the "thrusting aside, or treading down of all competitors". To us that method is one which, among animals, turns on the actuarial expectation of female offspring from different female individuals, a concept as unemotional as a definite integral; and we can recognize that quite other, though equally natural, methods of evolution may occur when it is societies and not individuals which are in question. Moreover, being no longer hypnotized by the methods of evolution, we can see its results; and they cannot be adequately summarized as an increase in bloodiness, fierceness and self-assertion.

Huxley, in fact, was morally outraged by what he took to be the character of the cosmic process, and was therefore forced to exhort civilization to combat it. With our present ideas, the general character of the cosmic process, or as we should now say, of the course of evolution, does not seem so morally offensive that we cannot accept it. To return to our question, we must accept the direction of evolution as good simply because it *is* good according to any realist definition of that concept. We defined ethical principles as actual psychological compulsions derived from the experience of the nature of society; we stated that the nature of society is such that, in general, it develops in a certain direction; then the ethical principles which mediate the motion in that direction are in fact those adopted by that society. Of course the good is, as the anthropologists pointed out, different in different societies, and particular cultures which regress may be actuated by principles at variance with the cosmic process. But in the world as a whole, the real good cannot be other than that which has been effective, namely that which is exemplified in the course of evolution. It should be noted that this, if you will, cosmic fatalism, does not imply a fatalistic attitude to the evolution of any particular section of the world, for example, of the society of which one happens to be a member.

It is, then, finally clear that science is in a position to make a contribution to ethics, since ethics is based on facts of the kind with which science deals. And the nature of science's contribution is also clear; it is the revelation of the nature of the character and direction of the evolutionary process in the world as a whole, and the elucidation of the consequences, in relation to that direction, of various courses of human action.

But the practical difficulty remains. The fundamental features of an ethical system are formed, as part of the super-ego, in the very early years of life. A child learns at its mother's knee that aggression must be controlled; and it learns a very little later that taunting its younger brother's weakness is a form of aggression; but when does it learn that adopting an unscientific attitude to the social problem of nutrition is also aggression? Most of the scientific contributions to ethical thought are of a kind which seem, at the present time, difficult to convey in the early formative years in which the most effective features of the super-ego are being laid down. Perhaps this appearance is deceptive, and perhaps after a few generations the fundamental notions of the scientific outlook will be so deeply incorporated into normal life that they can be transmitted by the unconscious gestures of mothers and nurses. An adequate psycho-analytical study of people who have grown up in Soviet nurseries might tell us whether this is too wildly optimistic. But in any event we should do well not to neglect the second line of attack, but should study deeply how the intellectual content of the super-ego may be modified in later life, and the data which we can provide about the nature of the cosmic process

appropriately attached to the powerful general principles about love and aggression which are by that time already in existence. It is the profoundest of scientific principles that a theory must work in practice; and that applies to scientific ethics no less than to the latest modification of the quantum theory.

[1] Carnap, R., "Philosophy and Logical Syntax", Kegan Paul (1935), 24.
[2] Riviere, J., "Love, Hate and Reparation", Hogarth Press (1937), 9.
[3] Wittgenstein, L., "Tractatus Logico-Philosophicus", Kegan Paul (1919), concluding sentence.
[4] Freud, S., "The Ego and the Id." Cf. "General Selection from the Works of Sigmund Freud", Hogarth Press (1937), 259.
[5] Freud, S., "New Introductory Lectures on Psycho-analysis", Hogarth Press (1933), 84.
[6] Klein, M., "The Psycho-analysis of Children", Hogarth Press (1932), 195, 197.
[7] Engels, F., "Feuerbach", Lawrence, n.d., 62.
[8] Engels, F., "Feuerbach", Lawrence, n.d., 47.
[9] Huxley, T. H., "Evolution and Ethics", Macmillan (1894), 83.

I FIND myself in fundamental agreement with Dr. Waddington, though I should base my argument on an epistemology more explicit than his own. To start off, I would aver, with Mach, that "bodies or things are compendious mental symbols for groups of sensations—symbols that do not exist outside of thought". The basis of all knowledge is experience. So-called external objects are constructs from experience: equally the doctrine of evolution and the view of the universe summed up in the Ten Commandments are constructs from experience. Of course, the experience may be partial: elements in it may be false (that is to say, unconfirmed by the majority of our fellowmen). The activity of the mind which links together elementary perceptions and fashions the constructed symbol may be inadequate to make a symbol which shall cohere with other symbols as we try to picture some wide region of the universe in which we find ourselves. But by a process of trial and error, in which the individual constantly checks his experience by that of others, the race has gradually created, among other ideas, those which we distinguish as external objects, laws of Nature and ethical principles.

We assume that there is an external world of objects to which our bodies belong. But, if that world exists, is our picture of it correct? We cannot say, for we cannot transcend human limitations. Are our scientific laws accurate? Probably not: they correspond, however, to humanity's present state of mental development. Can we say that our ethical standards and the commands by which we seek to make them effective are sound? They, too, are as partial, as transitory, as our supposed knowledge of the spiritual character of the universe.

Are then our scientific laws and our ethical principles of no value? By no means. They are approximations to truth, nearer than those which were reached in the past and later modified or even discarded by the growing wisdom of the race.

Unfortunately, the problem of the mind-body relation is so intractable that it is difficult to say how far intellectual and ethical tendencies are inherited. I would agree with Dr. Waddington in affirming Goodrich's conclusion that all characters are both inherited and acquired. The genes carry certain modes of reaction to environment. A relatively homogeneous community is built of the same stock of genes changed to some extent by recurring mutations; and an individual born into it assimilates with especial ease the community's intellectual, social and ethical formulation of experience.

Is Dr. Waddington quite fair in his strictures of T. H. Huxley? The evolutionary process on earth, until the rise of the placental mammals with their increasing parental affection, was non-moral. "Nature red in tooth and claw" is an actual fact. Huxley was right in asserting that between man and the cosmic process as it has been, there ought to be war. The strongest objection to ethical theism lies in the fact that the creative process has been non-moral. But just as evolution has been a creative process in that new things, and in particular man himself, have emerged in it, so it may well be that the process itself is being transformed: no longer, it may be, are new animal forms being evolved, but new levels of spiritual understanding are emerging. Boutroux died twenty years ago, but his "Religion and Science in Contemporary Philosophy" is not out of date. He said: "According to the results of science herself, there is nothing to guarantee the absolute stability of even the most general laws that man has been able to discover. Nature evolves, perhaps even fundamentally." He added that, if the remotest principles of things are thus transformed, that very transformation must obey laws which are analogous to the immediately observable laws of experiment. Are we wrong behind such change to find purposive activity, to postulate God as its source, and to see in the ethical change which results from the growth of human experience His progressive revelation of Himself?

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COMMENT on Dr. Waddington's important and interesting paper is difficult because it raises so many questions which are highly controversial. Only a treatise could deal with them all. I must confine myself to some rather disconnected jottings. Frankly, I am not quite clear about the main

thesis. If it is that the natural sciences have a valuable contribution to make to the study of ethics, few would deny it ; if it is, as I think, the contention that the central problem for ethics can be solved by the method of natural science, that seems to me a disastrous error. No doubt science can throw light on the way in which minds come to apprehend values but, as it seems to me, it cannot determine whether they are truly values or only appear to be such, nor can it determine the scale of values, if any.

A certain scepticism about some of the alleged findings of science may be permitted. For example, the super-ego appears to me to be a piece of useful mythology ; probably it helps to "explain" the process by which we reach ethical maturity, but may it not be misleading to treat it as an "entity" ? The important fact is that mature and sane men have ideals which, as they believe, commend themselves to their reason, and sometimes they have imaginary pictures of themselves as they know they ought to be. Again, the diversity of moral codes at different levels of civilization can be exaggerated. Virtues which are honoured among us, such as courage or even kindness, are honoured in crude and more limited forms by people of lower cultures. The development of moral ideas is not determined wholly by social condition ; there is a dialectical development of the ideas themselves, and if it is true to say that societies create ideas, it is even more true to say that ideas create societies.

The use made of the psychological concept of "compulsions" perplexes me. As I understand it, a compulsion is an irrational and perhaps irresistible tendency arising from the unconscious. The moral experience in its authentic form is surely the opposite of a compulsion. The agent believes himself to have the responsibility of choice and the ethical "ought" is recognized not as something which must be obeyed but something which deserves to be obeyed, though it may be difficult and unpleasant. "Had it power (compulsion) as it has authority, it would absolutely rule the world." I am even more perplexed by what seems to be asserted about the goodness of evolution or even of all existence. "We must accept the direction of evolution as good simply because it *is* good." I think I must have failed to grasp this point, because in the preceding sentence we are told that revised ideas about evolution enable us to feel that it is not morally offensive, as T. H. Huxley thought it was. This seems to imply that Dr. Waddington has considered the course of evolution and found that it is not morally offensive. Now, how, on his own principle, could he possibly do that ? What criterion did he apply ? No doubt, as a theist I am bound to hold that there is a direction in evolution or rather that organic evolution is a part, perhaps a very small part, of the Divine purpose, but I see no reason to suppose that at any given moment the actual direction of evolution is towards higher values, and this is pre-eminently the case when the process is largely determined by human will.

There is a most fundamental problem raised for ethics by the evolutionary hypothesis. I wish that Dr. Waddington had said more about it. Shortly it is this : evolution appears to suggest that all moral ideas are relative, but the moral consciousness regards some of them as absolute and unless it does so the moral life is simply abolished. We are confronted with the situation now in every home. There are some things of such value that men ought to be prepared to die for them ; it is reasonable to be prepared to die for them. Why ? Men answer with action and, it may be suspected, deplorably confused notions of ethical theory ; but they act because, in their simple way, they believe that the voice of duty comes from a Source deeper and more intimate than the course of evolution.

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I JOIN issue with Dr. Waddington on two points. First, when he offers, as a typical example of a judgment that is at once ethical and scientific, the statement "You are an animal of such a kind that you must consume 7 mgm. of vitamin C per diem, and should consume 10 mgm.". I see nothing ethical here at all. The rules acquire ethical significance only when in a given case I judge the effort after survival, to which it prescribes the means, to be morally right or wrong. If I am the father of a family and there is only a limited supply of vitamin C available, it may be my moral duty to throw the rule to the winds and forego the means to my survival. The 'must' of the rule is not the unconditional 'ought' of morality, but the condition of attaining an end, as to the morality of which the rule says nothing. The 'should' in the last clause is ambiguous ; it may mean either 'you ought to' or merely 'you will have a better chance of surviving if you do'. The former meaning alone is ethical, but I fancy that Dr. Waddington intends the latter. He may reply that he sees no difference between the two, any more than when on a later page he identifies what is pleasurable or what leads to pleasurable results (two different matters, by the way) with what is good. We seem to be back in the dear old days of Herbert Spencer. Do fallacies never die, however often they are confuted ? If 'you ought' is identical with 'you'd jolly well better', and if 'this is good' is only another way of saying 'I find this pleasant', then the moral consciousness

is an illusion and a cheat, and the sooner we stop talking about it the better.

Dr. Waddington puzzles me, again, when he argues that the evolutionary process itself supplies us with a criterion of good, and that we need no other. I fail to see what he means by saying that this "cosmic fatalism does not imply a fatalistic attitude in the evolution of any particular section of the world", for example, of one's existing society. The 'psychological compulsions' with which he identifies ethical principles are surely, in his view, determinant of every act of every citizen in every race and age. If so, morals, whose business it is precisely to draw 'class-distinctions' among our natural impulses, vanish from the picture. Moreover, what ethical criterion can be derived from the scientific doctrine of evolution? Biology knows nothing of the qualitative distinction of higher and lower, better and worse; it can only display the continuity in the modifications of species through descent, showing what form of life succeeds what, and that certain more complex organisms have less complex organisms as their temporal antecedents. If the second law of thermodynamics should work its will and if all mind and all life should be eliminated from our planet, the process would be just as much an evolutionary process, in the sense relevant to biology, as that by which man has arisen from the ape. Apart from ethical presuppositions read in from other and non-scientific sources, evolution has no concern with value. The cosmic process is not indeed, as Huxley thought, immoral, save for those who indulge the 'pathetic fallacy' and interpret it in the light of their own emotions; but it is wholly amoral. The scientific study of it cannot teach us what is good or what we ought to do. It cannot even say 'must' in its predictions; it can tell us only what has been, what is, and what, in varying measure of probability, will be in the time to come. It cannot tell us that what will be is right or good.

These are my two grounds of dissent from Dr. Waddington, and I think they are fundamental to the issue. With much else in his article I cordially agree. But I venture to add a remark that travels a little beyond the scope of his discussion. It seems to me important to grasp the bearings of this amorality of Nature on our present world troubles. Are they not in large measure due to the fact that our knowledge of science, especially in its practical applications, has outrun, far outrun, our morality? Science has placed instruments of world-shaking power in the hands of rulers who abuse them for their own unrighteous ends. These instruments are in themselves, like physical Nature, non-moral. Neither Nature nor science is to blame for their misuse by man. Morality lies in the will to good, immorality in the will to evil, that is, in the choice of ends, not in the means to their attainment. Of those ends, whether they be good or whether they be evil, science, for all its glory, can tell us nothing.

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I PROPOSE to touch very briefly on those points in Dr. Waddington's article with which I agree, although, even where I agree, I cannot resist the temptation of entering a disclaimer against his uncritical taking over lock, stock and barrel of the pretentious jargon with which psycho-analysts disguise the commonplaceness of their observations upon the obvious. What, for example, does all this talk about the super-ego and its imposition upon the personality—is it, for example, upon "a merely receptive and featureless individual" or upon one who is "himself a factor in the origin of his super-ego"?—really amount to? That there is an individual person exhibiting certain specific characteristics which distinguish him from others—my dislike, for example, of the taste of marzipan, or my delight in the smell of privet; that this individual is born and grows up in an environment and that his resultant beliefs, including his ethical beliefs, are the result of the impact of the environment upon the characteristics which distinguish him from others, as well as upon those which he shares with others. That, as it seems to me, is all that Dr. Waddington and Melanie Klein are saying, and, put like that, it scarcely seems to justify the fuss.

I agree again with Dr. Waddington's interpretation of Marxism. I agree, that is to say, that Marx *did* provide for changes in, as well as conservation of systems of, social ethics, while retaining my private opinion that the real agents of ethical change are to be found less in the factors that Marx and Dr. Waddington emphasize than in the appearance of an ethical 'sport' in the shape of a Christ, a Buddha, a Socrates or a Blake who points the way to new levels of conduct and new standards of value to which in course of time the accepted moral codes of society as a whole gradually creep up. Or don't creep up! If they don't, then, to adopt a biological metaphor, the 'sport' has failed to breed true. I deliberately employ the biological metaphor in witness to my belief that the process of evolution still proceeds by 'mutation', although the scene of its operations has now been largely transferred from the physical to the mental and spiritual spheres.

So much having been said by way of not very impressive agreement, I come to my two major quarrels.

About the first I must say very little, not because it is not important but because it is subsidiary to Dr. Waddington's main thesis. He says that, if the contents of super-egos are taken to consist of general rules, they must be rules "of an extremely vague character". In more familiar language, the deliverances of men's moral consciousnesses vary so much that no general ethical principles as to what is good and right can be laid down.

I deny it, and claim that we do in fact all know, and always have known, that unselfishness is better than selfishness, kindness than cruelty. What is more, we can all recognize a case of cruelty when we see it and know that we ought to try and stop it—(the fact that we usually do not try is not to the point). I should go further and maintain that we do all of us know the sort of way in which we ought to live; that we know, in fact, that we ought to live very much as Christ enjoined. We may say that Christ's prescription for good living is wholly impracticable or is much too difficult; but that does not alter our conviction that it is the right prescription. The difficulty about ethics is not that we don't know what is right and know with a good deal of particularity, but that we lack the will or the ability to act in accordance with our knowledge.

Secondly, on Dr. Waddington's main point, I cannot understand how anything can be measured without a ruler which is external to and other than what it measures. Now to adjudge a movement as good or as bad—witness in this connexion Dr. Waddington's talk about "the 'good' direction of evolution"—entails that some meaning is understood to be conveyed by the words good and bad which serves as a standard of measurement by reference to which the movement is evaluated. Now this meaning cannot itself be part of the process which it is invoked to evaluate, any more than a ruler can be part of the length which it measures, or a man can lift himself by his own braces. Dr. Waddington points out that later stages of evolutionary development include the earlier. Certainly they do, but what of it? The later stages of a travelling snowball include the earlier, but that does not mean that the snowball's journey is ethically valuable or worthy of praise. It may not even be well advised; if it is heading for a precipice it is ill advised. The point is surely obvious enough. When Dr. Waddington affirms that evolution is moving in the right direction or is progressive—it is "good", he says, "simply because it *is* good"—he is applying ethical standards to it. Now all progress implies movement in a direction and direction implies a goal. If I put myself in the Strand and set my legs in motion, there is movement or process, but until I know whether I want to go to Charing Cross or Temple Bar I cannot say whether I am progressing or not. But the goal cannot be part of the process which seeks to realize it.

Once this is understood, it will be seen that the kind of question which Dr. Waddington is putting, when he applies the notion of 'right direction' to evolution and then proceeds to inquire whether our present direction is "right", is, *if we are to proceed on his premises*, like the question "Is it better to take the right fork or the left?" when asked by somebody who does not know where he wants to go; while further questions relating to the speed of the advance are like asking whether it is better to travel in a 40- or a 10-h.p. car, when you don't know where you are travelling, or whether it is good to travel at all.

C. E. M. JOAD.

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IN commenting upon Dr. Waddington's article, the need to be brief compels me to concentrate upon a single point and to say too shortly what requires to be argued with the help of detailed examples. The point I select for comment is that the contribution of science to ethics lies in its revelation of "the character and direction of the evolutionary process in the world as a whole", and that the examination of this direction will yield the criterion of human action. Although I am in agreement with much that Dr. Waddington says here and in his little book, "The Scientific Attitude", I find a serious difficulty in understanding his present argument. He maintains that the "real good" is that which has been effective, that is, that which has been exemplified in the course of evolution; accordingly, he argues that "we must accept the direction of evolution as good simply because it *is* good according to any realist definition of that concept". Presumably the word "must" in this sentence means "are logically compelled", so that our acceptance is an admission of what follows logically from the "realist definition" of good.

It is not, however, clear whether this is what Dr. Waddington means since he at once proceeds to drag in the notion of fatalism, in order to ward off a possible charge of being fatalistic. But such a charge would not make sense if I have correctly interpreted the phrase "we must accept". The difficulty is increased when we take note of the context in which the sentence I have quoted occurs. Dr. Waddington is disagreeing with T. H. Huxley's protest against accepting the cosmic process as the standard of ethical progress. The answer he makes consists of three parts, or—as I prefer to put it—he gives three different answers: (1) the method of evolution is to us—as contrasted with Huxley—"as unemotional as a definite integral";

(2) the results of evolution cannot be adequately summarized as an increase in bloodiness, etc.; (3) the course of evolution does not seem to us now "so morally offensive that we cannot accept it". But (3) seems to me to make a muddle of the argument. If good is defined as that which is effective, that is, that which is in the direction of evolution, what is the point of answer (2)? And if the concept upon which the method of evolution turns is unemotional, then why, again, bring in (2)? In short, it is not compatible with Dr. Waddington's "realist definition" of "good" to speak of the course of evolution as morally offensive or morally admirable. But his answer (2) suggests that he does think it necessary to show that Huxley was mistaken in his estimate of the blood-thirsty character of the struggle for existence. Suppose Huxley's estimate had been correct: would it make sense to say that the evolutionary process was morally offensive?

L. SUSAN STEBBING.

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I HAVE read with great interest Dr. Waddington's lucid and well-reasoned essay in speculative metaphysics, into which he has ingeniously woven hypotheses derived from Freud and Marx, but I fail to see the alleged connexion between science and ethics. He says that the contribution of science to ethics is "the revelation of the nature of the character and direction of the evolutionary process in the world as a whole, and the elucidation of the consequences, in relation to that direction, of various courses of human action". (This might almost be a quotation from Herbert Spencer.) The direction of the evolutionary process may have been revealed to Spencer or Dr. Waddington, but not by science. It is said that Amœba and Hydra represent early stages in animal evolution, yet there are plenty of them alive still. For all we know they may survive long after Homo has perished by mutual slaughter. Would that make them better or worse from the scientific point of view?

The process of evolution has thrown up Hitler, Himmler, Goebbels and their like. If they were to win the War, would that show the direction of the evolutionary process? Evolution has produced the nightingale and the kingfisher we admire; also Sacculina, the parasite of the common shore crab, and also the matrimonial habits of spiders, which we do not admire. Does science tell us which is better? I select these examples because they are of no evident economic importance and our judgments may be considered disinterested. I am not arguing that these judgments of approval or disapproval are subjective or irrational, only that they are outside the scope of science. By reason of its method the only values within its scope are truth and error as judged by logical consistency and conformity to fact. If the logical positivists confined themselves to this assertion they would be on safe ground. I am not arguing, either, that Dr. Waddington's theory is wrong, only that, like every ethical theory (including the theory that there are no ethical distinctions or that they are meaningless), it rests on *a priori* presuppositions it is best to be honest about.

On a minor point, I must protest against the notion that it is a recent discovery that different societies have different moral codes. It seems to have been known to the author of the "Odyssey", and certainly to Herodotus a few centuries later. Lastly, may I recommend Dr. Waddington (and others interested in the relations of science and ethics) to read "Five Types of Ethical Theory" by Prof. C. D. Broad, where he will find his own type of theory labelled and docketted; and specially to read p. 284—the last page but one?

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MUCH appreciation is no doubt widely felt for Dr. Waddington's statement that, if various modern theses are correctly interpreted, ethical judgments are allowed by them to be "statements of the same kind as scientific statements". One also agrees with his view that the putting forward of these theses has somehow persuaded many people of a lack of any link between science and ethical systems. This seems a natural temporary reaction belonging to what Samuel Alexander called the deanthropizing phase of thought. For millennia, men have sought authority for social codes in anthropomorphs created by their imagination outside the evolutionary sequence and empowered to insert into it new items—dispensations they have been called—from time to time. The comparative method in the study of man, outstandingly represented by Frazer, has vividly suggested that what were held to be impregnable rock-fortresses of traditional belief are, rather, erratics in the moraines of folk-lore. The old authority has gone. It withered too, at a time when an individualist age was obsessed with the idea of Nature red in tooth and claw, and even a Huxley could suggest that men's ethical systems must stand in antagonism to the cosmic process.

In their various ways Alexander, Lloyd Morgan, Smuts and Sherrington are trying to get us beyond the inevitable phase of disorientation. Unlike older systems, the work of science must not claim to give us something complete and unchanging;

it must have ever-recurring readjustment as its key note. Would that those who are busy making blue-prints of a better world would realize this; so many of their schemes are static! Perhaps a main contribution of the humanist at the present juncture is the thought that man is a social being, and that, within society, there is an unceasing and not always successful struggle towards freedom of conscience, towards replacement of external by internal factors. One may add that the survival-value of this freedom is related to the facts of observation and inference, namely that life's history on earth has been a process of ever-recurring readjustments, and that, with few exceptions, the fate of those forms which did not readjust has been extinction. At the same time, it should be remembered that these developmental adjustments are selective; if some features are enhanced, others are atrophied. So it is not very wise to suggest that the later include the earlier; that unduly simplifies the idea of change and suggests acceptance of the rather crude notion of the inevitability of progress.

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OUT of the breakdown of traditional systems of thought, glimmers of new light appear, islands of solid land emerge out of the chaotic flood. Dropping metaphor, the question is whether any new system of thought, sufficiently strong to provide the foundation for living, can be evolved in time to substitute reintegration for disintegration. As science has played a major part in bringing about the disintegration of the old, it should attempt to do at least as much in the new integration.

Dr. Waddington's interesting article is a valuable contribution to this. As he points out, psychology, anthropology and sociology have largely contributed to the breakdown of traditional views on ethics. He might have added many other sciences. Evolutionary biology is one, with all its implications as to human ancestry, the struggle for existence, and the abolition of the idea of purpose in evolution. All the physical sciences have contributed, by providing a mechanistic explanation of natural phenomena previously attributed to supernatural powers and often invested with an ethical aura—witness the legend of the rainbow in the Old Testament, or the frequent view of lightning, floods or earthquakes as expressions of Divine anger. Similarly, physiology and pathology have removed deformity and infectious disease from the ethical sphere; they are no longer considered as Divine retribution for moral lapses.

When it comes to the constructive side, I have little to add to Dr. Waddington's interesting thesis. He might, I think, have pointed out that in some cases science indicates a new ethic, or at least a new type of ethical approach to old problems. This may be illustrated by my last example. We can no longer believe that pestilence has any connexion with moral lapses in the conventional sense, or with the failure to observe certain rituals or to believe certain dogmas; but we can lay down certain new types of moral duty arising out of the nature of infection—duties both individual and social, concerning cleanliness and the prevention of disease and of its spread.

I have two specific comments. One concerns the basis for the quality of absoluteness and other-worldliness possessed by the super-ego and the systems of ethics for which it is the vehicle. Dr. Waddington makes what I believe to be the quite novel suggestion that this is connected with the breakdown of the solipsistic early phase of the child's existence. While this may be a contributory cause of the other-worldliness, I cannot feel that it accounts for the absoluteness, for the fact that certain aspects of morality are felt as a categorical imperative. The origin of this, as I have elsewhere suggested, must more probably be sought in the all-or-nothing method adopted in higher animals for avoiding conflict. This has been proved to operate to prevent conflict between antagonistic muscles and between competing reflexes. Observation shows that it must also normally apply to competing instincts in sub-human vertebrates. Finally, all we know of human psychology indicates the strong probability that it operates in repression in early life. Man is the only organism in which conflict is normal and habitual, so that some form for minimizing its effects is essential; and this will be of the greatest importance in early childhood, before sufficient experience has been accumulated to enable conflict to be dealt with empirically and rationally.

The antagonistic forces which hold down repressed ideas and impulses are kept away from the main body of consciousness; hence the apparent externality of ethical law. They are held there by the strong but automatic processes of repression; hence the compulsiveness of the super-ego. And repression is, or attempts to be, total, seeking to keep certain impulses wholly out of consciousness; hence the all-or-nothing character of the ethical prohibitions of the super-ego.

Some repressions are more complete than others; and in many cases the degree and method of repression can be modified or the prohibitions of the super-ego transferred in their operations from one field to another. Hence we may say that a great part of our ethical development will consist in diminishing the absoluteness and compulsive-

ness of our early categorical imperatives, and in altering the field to which they apply, in the light of reason and experience.

Put in another way, we may say that primitive and absolutist ethics, based on the non-rational and unconscious processes of the mind, inevitably tend to limit human activity by locking up conflicting psychological 'energies' in the repressive mechanism of the unconscious. For constructive and truly humanistic ethics, we need to liberate these forces from their unconscious grappling, through reason and still more by appropriate education and by opportunities for fuller living.

The other point which I would like to make is perhaps even more fundamental. Dr. Waddington writes: "an existence which is essentially evolutionary is itself the justification for an evolution towards a more comprehensive existence". While this is true, it is so general as to smack of Panglossic optimism. It is an observed fact that the majority of evolutionary trends are either irrelevant to progressive change, or are even opposed to it in direction, or are inherently limited specializations. As I have set out at some length elsewhere (in the first essay in my book "The Uniqueness of Man") evolutionary progress can be objectively defined, and further is a rare phenomenon; the potentialities of further true progress now appear to be restricted to our own species, though there is no guarantee that we shall achieve them. The problem here is thus to study the possible directions of change; to decide which make for progress and which do not; which make for unlimited and which for limited progress; and to attempt to adjust our social systems and our ethical ideas in such a way that, as Dr. Waddington rightly points out is possible, they should form a mutually reinforcing whole, making for the maximum speed of progress in the correct direction.

Dr. Waddington points out the difficulties arising from the fact that the ethical systems of different societies differ enormously, one conception of the good often contradicting another. Here again there is an evolutionary parallel. Thanks to the work of Sewall Wright, we know that small and isolated animal and plant species will often show 'accidental' differentiation, which is not necessarily biologically advantageous, and may sometimes even be disadvantageous. The same appears to apply to the evolution of cultures.

Further, as Darlington has pointed out in his recent book, "The Evolution of Genetic Systems", certain evolutionary changes may be of immediate advantage, but of eventual disadvantage in robbing the stock of evolutionary plasticity and adaptability. Here again there are doubtless parallels from ethics. The short-term efficiency of ruthless State dictatorship as opposed to the inevitable long-term triumph of more humanistic systems is a case in point.

With such modifications, Dr. Waddington's thesis of ethical systems as indispensable social organs, derived from the impact of a changing external world on the minds of individuals via the social environment, but themselves then helping to effect changes in the external world and the social environment, appears to be a fundamental one, and worthy of the most careful study.

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SCIENCE AND MARXIST PHILOSOPHY

IT is a little more than ten years since the London Congress on the History of Science. It was there that the Soviet delegation first brought effectively to the notice of British men of science the contributions that Marxist thought had to make to the natural and social sciences. The symposium organized by Marx House held during August 16–17 has served to show that there is now a widespread and growing interest in this development, and that we are clearly on the way towards a more profound and comprehensive appreciation of science as a human social activity. The two days sessions of the symposium had as keynotes two of Engels' works, "The Dialectics of Nature" and "The Origin of the Family", illustrative of the scientific and sociological aspects of his work.

The first was introduced by Prof. H. Levy, who discussed the changes that the present century has brought about in the attitudes towards philosophy and science, contrasting the older tendencies towards pure science cultivated for its own sake with those of a planned science in the service of the community. He showed how the former tendency is working itself out in the direction of the claims of *a priori* knowledge, as evidenced in the recent discussion in NATURE between Jeans and Eddington. The majority of men of science, however, are coming more and more to see their activity as part of social enterprise, and to realize that science represents the achievement of human action in an infinite field of ignorance; indeed, that in a sense, the man of science creates new ignorance with every problem he solves. The old absolute views of knowledge and logic are giving way to one in which probability has a much greater part. We need for the advancement of

science a philosophy that will take all these tendencies into account; and the basis of that philosophy has been laid by Marx and Engels.

Dr. J. Needham provided an interesting analysis of Prof. Whitehead's philosophic opinions. Although Whitehead probably never read Marx, he was led, in attempting to achieve a unitary view of biological and physical phenomena, to an attitude essentially similar to that of the dialectical materialists. In his insistence on the close relation between succession in time and a series of envelopes in space, Whitehead developed a hierarchical series of organizations passing from the purely physical structures of atoms to those of animals, and ultimately societies. Whitehead failed, however, according to Needham, to push his arguments to any practical conclusions, not seeing that any further stages in organization were yet to come.

Prof. J. B. S. Haldane took up the question of the development of science since the writing of "Dialectics of Nature". In that book Engels stressed the chief scientific discoveries—notably the law of the conservation of energy and the theory of evolution—that led to the breakdown of the older and essentially static views of the universe. Haldane carried the analysis on through the achievements of present-day science. He laid particular stress on the fact that the breakdown of boundaries between the different sciences has progressed much further than in Engels' time. The development of modern physics, with its fundamentally dual aspects of wave and particle, fits in particularly well with the dialectical picture that Engels developed. Recent cosmological research has shown that even the laws of physics cannot be taken as fixed and unalterable, but are only so in relation to our very limited experience of time. Everywhere, the picture of the universe as a series of transformations brought about by internal instabilities is gaining ground. The great developments of biochemistry and genetics are providing new links in the chain that joins the inorganic and the organic worlds.

The second day of the symposium was devoted to social and anthropological subjects. Here, as in the natural sciences, a remarkable change has come about in the last few years. Emphasis on the importance of social and economic conditions in anthropological and historical studies has become almost universal. Prof. G. Thomson in his introductory paper provided a brilliant study of that neglected nineteenth-century pioneer, Morgan, the virtual discoverer of the universal form of society, based on clan organization and matrilinear succession, that has preceded our own individualist family organization. Engels took up Morgan enthusiastically in his "Origin of the Family", but more recent anthropological work seems to discredit many of Morgan's conclusions. Prof. Thomson discussed these criticisms in the light of the most modern evidence, and showed that though Morgan's view is necessarily limited by the comparatively undeveloped anthropology of his time, his main conclusions have only been confirmed and enlarged. Similarly in physical science, the reaction against the disturbing character of these views led to a sheer obscurantism and the denial of any principles in history or in social development.

Dr. Barbara Ruhemann discussed the economic origins of the universal totemism that accompanies the clan family organization, and further discussion on this subject was provided by papers by Mr. Lionel Naftalin on the relations between slavery and feudalism, and by Prof. Pascal on the *gens* in primitive Germanic society. All these went to show how rich a clue to the study of social origins is furnished by the work of Morgan and Engels.

The new unification of the sciences and humanities was brought out in a striking way in two papers on medicine presented by Prof. B. Farrington and Dr. Ruscoe Clarke, on the subject of the social significance of medicine in early times, and at the present day. Prof. Farrington traced the way in which medical practice has turned from primitive social health service embodied in practical healing lore to a pretentious and specialized medical practice for the benefit of the rich: showing how the emergence of a leisured class has distorted the development of medicine. He pointed out how from the period of the rise of the Greek City State to the eighteenth-century enlightenment, medicine consistently neglected a study of the diseases afflicting the common people, and even more of the special diseases which their conditions of work produced. The breakdown of this attitude began in the eighteenth century with the pioneer studies of industrial diseases by the Italian doctor, Rammztini. Dr. Clarke stated that economic factors in present-day society distort medical practice and theory. Here, again, the inability to solve the real problems of public health in a society which cannot provide basic nutrition and environment has led the older school into a complete denial of medicine as a science, and to the emergence of irrational and mystical elements.

The symposium, to judge from the unexpectedly large attendance and the animated discussions that followed each contribution, must have supplied a need that has existed for some time. There is room, however, for much more effective coördination of the different contributions, and for developments both in the direction of far more thorough discussion among experts, and clearer popular exposition.

J. D. BERNAL.

NEWS AND VIEWS

Augustin Pyramus de Candolle, For.Mem.R.S.

ON September 9 occurs the centenary of the death of the famous Swiss botanist Augustin Pyramus de Candolle, the contemporary of de Saussure and Prévost and the father of Alphonse de Candolle (1806–93). Born at Geneva, February 4, 1778, he was the son of a magistrate of the republic of Geneva and received a good education. His taste for botany was stimulated by attending the lectures of Prof. J. Vaucher (1763–1841), a founder of the Geneva Natural History Society, and while still in his 'teens de Candolle went to Paris, residing at the house of Dolomieu and becoming acquainted with such as Vauquelin, Fourcroy, Cuvier, Lamarck and Desfontaines. In 1798 owing to the decline, through the political upheaval, of the family fortunes, he took up the study of medicine, but botany still remained his chief study, and in 1804 he began to lecture in the place of Cuvier at the Collège de France. In the summer of 1806 he began a series of official botanical journies through France and Italy, and in 1810 was appointed to the chair of botany at Montpellier with charge of the old botanical gardens.

In 1816 after the Restoration, de Candolle returned to his native land and was made professor of natural history at Geneva, a post from which he retired in 1834 through ill-health, when he was succeeded by his son. A man of the highest character, he was honoured alike by his fellow citizens and by foreign societies. His writings, which began with a memoir on lichens, were very numerous. His great work "Regni Vegetabilis Systema Naturale" was begun in 1818 but the too extensive scale of his work led to the commencement of his "Prodromus Systematis Naturalis Regni Vegetabilis", which was continued after his death by his son and other botanists. It is related that while at Montpellier, after the fall of Napoleon, he was instrumental in saving the Emperor's mother and sister Pauline from the danger of a mob by hiding them in the botanical garden. "Like all truly great men", it has been said, "de Candolle was modest; and the consciousness of his own worth is shown by the lenity with which he judged others, and in the heartiness with which he applauded their services."

Augusto Murri (1841–1932)

PROF. AUGUSTO MURRI, one of the most celebrated Italian physicians of recent times, was born at Fermo on September 8, 1841. He studied medicine at Camerino and Florence, where he qualified in 1864. After receiving post-graduate instruction in Paris, Berlin and Vienna, he returned to Italy, and after a period of private practice became assistant to Baccelli in the medical clinic at Bologna in 1871. Five years later he succeeded Baccelli as professor of medicine, and in spite of many tempting invitations from other Italian universities he remained at Bologna until the retiring age of seventy-five in 1916. His principal publications were devoted to the regulation of temperature, the theory of fever, the Cheyne-Stokes phenomenon, hæmoglobinuria from cold, tumours of the cerebellum, clinical lectures, medico-legal reports, organotherapy and glandular insufficiency. In 1912 he was the recipient of a *Festschrift*. Selections from his works were published by Gnudi and Vedrani in 1919. He died at the advanced age of ninety-one, and on the day of his burial the city of Bologna founded an Augusto Murri prize in medicine.

Contra-rotating Airscrews

MESSRS. ROTOL AIRSCREWS, LTD., have now completed the development, to the production stage, of a constant speed contra-rotating airscrew, the principle of which was mentioned in NATURE of May 17, 1941, p. 602. This model consists of two three-bladed airscrews mounted on the same centre line, normally the engine hub, rotating in opposite directions. The aerodynamic efficiency of this device is not appreciable at flight speeds of less than three hundred miles per hour, but above this it is worth while, and at five hundred miles per hour it gives an increase of about 7 per cent. One particular example weighs 497 lb., compared with 450 lb., for the normal airscrew. Metal or wooden blades of any detachable type can be used equally well. The de Havilland Aircraft Co., Ltd., and the Fairey Aviation Co., Ltd., have also announced the production of contra-rotating airscrews.

The development of this device is the logical answer to the peculiar conditions arising in war machines, in that the increasing powers given by the newer aero-engines are not used to equip larger aircraft, but rather to improve the performance of those of the present-day dimensions. It is not possible to obtain more blade area by increasing the diameter of the single propeller because of ground or water clearance, and also because the blade tip speed, being too high, would make that part increasingly inefficient. Reducing the rotational speed to counteract this would give more slip and make the rest of the blade less efficient, and would call for a considerable gearing down, as the higher-powered engine is usually of high speed itself. Obtaining extra area by increasing the number of blades is not practicable as the thrust of each blade is spoiled by the interference of the preceding blade. There are also other advantages in the flying operation of fighting aircraft which were discussed in the previous note in NATURE.

Architects and Post-War Reconstruction

THE Reconstruction Committee set up by the Royal Institute of British Architects to consider and formulate the policy of the Institute and allied societies in post-war reconstruction and planning in its widest aspects has organized its work in three sections. A small group has been appointed to carry out work involving analysis of the position of the architectural profession in relation to physical reconstruction, and also on practical considerations in connexion with

reconstruction on which the Government may seek advice from the profession. Consideration is being given to the question of professional status, particularly relating to a national planning authority and its regional and local administration, to town planning qualifications, covering an architect's qualifications for town planning and the possibility of including town planning in the curriculum of education of an architect.

A housing group, building legislation group, a building industry group and a building technique group which will consider building science and technique with reference to the probable shortage of certain building materials, and to the possibilities of standardization, prefabrication and the use of synthetic materials are also at work. These groups will record their findings in a concise report for submission to the main committee. A policy group has also been formed consisting of the chairmen of all these groups as well as of the publicity sub-committee which will deal with propaganda on broad lines to demonstrate to the public the immense opportunities underlying national reconstruction and the part the profession can play in this work. The groups are intended to concentrate on co-ordinating existing information rather than initiating new research and the committee has suggested that each group should submit a preliminary report within six weeks and progress reports thereafter at monthly intervals.

Great Britain and the U.S.S.R.

THE Executive and Social Relations Committees of the Association of Scientific Workers have transmitted the following resolution through the Soviet Embassy to men of science and technicians of the U.S.S.R.: "From the Executive and Social Relations Committee of the Association of Scientific Workers to the scientists and technicians of the U.S.S.R.: The Association of Scientific Workers, representing scientists in all branches of science in Great Britain, sends its wishes of goodwill and friendship to the scientific workers of the U.S.S.R. It considers that the closest collaboration in the technical and scientific spheres is essential to the speedy victory of the British and Soviet peoples in their common struggle against Nazi and Fascist aggression. To this end it urges the exchange of technical information and of delegations of scientists between the two countries, and the promotion of personal contact between workers in the same fields."

Monthly Science News (*M S N*)

THE British Council, at the suggestion of its Science Committee, has decided to issue a monthly broadsheet surveying scientific developments in popular terms. The broadsheet is being edited by Mr. J. G. Crowther, secretary of the Science Committee, whose name will be sufficient guarantee that the material presented will be both accurate and readable. The first issue is dated August, and contains paragraphs on the distance of the earth from the sun, a new breed of chicken in which sex is determinable at a day old, barrenness of fruit trees, the two types of diamond disclosed by X-ray examination, the hardening of insect cuticle, and measurement of the temperature of liquid steel. The Press is invited to reproduce any of the material without fee subject to acknowledgment by the initials *M S N*.

The Engineering Industry in the U.S.S.R.

AN informative article by V. A. Bary on "The Engineering Industry in Russia" is published in *Engineering* of August 15. He reminds us that until the eighteenth century, timber was the basic material of all Russian engineering works, and the skill of the carpenters who were the architects and builders of the old Russia was, and remained, of the highest standard of craftsmanship. The first Russian iron and steel industry was established in the central part of the Volga basin and in the Urals. Until the south of Russia developed its own coal and steel industry, the north was the only provider of these commodities and hence the priority of the northern carpenters among the Russian engineering trades. When the first steel tankers to carry paraffin from Baku up the Volga were built in 1880, the wooden-ship builders maintained a vigorous and for some time quite a successful rivalry, using wooden tankers ranging in displacement up to several thousand tons. Similar resistance was offered in bridge-building and other branches of structural engineering to iron and steel.

In 1913, the Russian iron and steel industry produced only about five million tons. In 1938, the output of iron and steel was in excess of 25½ million tons, as compared with the 35 millions produced in Germany. These commodities are the basic materials of engineering, and the comparative figures afford an idea of the growth of the engineering industry over the same period of time. Russia is still primarily an agricultural country, and one of the first directions in which intensive mechanization was pursued was that of providing tractors for farming purposes. There were in 1939 more than six thousand tractor stations distributed over the 540,000 square miles of cultivated land. Air transport of goods, passenger and mails has been extensively developed; 69,000 miles of air routes were in operation at the outbreak of hostilities.

War-time Catering in Canteens

A BOOKLET has just been issued by the Ministry of Food for the benefit of 'British Restaurants', industrial canteens and other large-scale feeding-centres. This booklet has been compiled as a result of a nine-months investigation and experiment in industrial canteens in all parts of England, Scotland, Wales and Ireland, and all recipes have been tested in such canteens. Each day's suggested meal has been built up on the principle of the Oslo breakfast, to provide in one meal a high proportion of the day's requirements of essential vitamins and mineral salts. Averaged over six consecutive days, the analysis is as high as that of the Oslo breakfast.

The aim throughout has been twofold; first to show how it is possible to provide attractive and palatable meals of a high nutritional standard under

the present difficulties of rationing and supplies; secondly, to take the present opportunity of food consciousness to change gradually the food habits of the majority of working-people in Great Britain so that the standard of the national diet is improved rather than allowed to deteriorate. For this purpose, it will be observed that all bread is given as national wheatmeal, a raw vegetable is included in every meal in some form or other, cooked vegetables are suggested in much larger quantities than is usual in canteens and oatmeal or wheatmeal flour is used freely in cooking. The booklet is being issued free to all 'British Restaurants', industrial canteens and Londoners' meal services. Copies can be obtained from the Nutrition Section, Food Advice Division, Ministry of Food, Vincent House, Vincent Square, London, S.W.1.

The Newcomen Society

THE Newcomen Society, which this year attains its majority, has recently issued its syllabus of meetings in Great Britain for the session 1941–42. The presidential address of Col. C. E. Davies will be read on November 12 after the annual general meeting. Thirteen papers are included in the syllabus. Among the subjects to be dealt with are automobiles, Suffolk windmills, spring balances, wood screws, and natural draught furnaces. Dr. Thurston is giving a paper on "The Evolution of Rider Planes for Aircraft", Dr. Herbert Chatley one on the "Development of Mechanism in China", and Dr. Dickinson is giving papers on Robert Stuart Meikleham and Joseph Bramah. Other papers relate to early engineering and iron-founding in Cornwall, the French civil engineers of the eighteenth century, and the famous firm of shipbuilders, Messrs. Normand of Havre. In the *Newcomen Quarterly Bulletin*, probably the last to be issued for the time being, are some interesting quotations from letters received from members in the United States.

Comet Okabayasi-Honda (1940*e*).

IN NATURE of March 29, p. 387, a note about this comet appeared, and it was stated that it was discovered at Tokyo on October 4, 1940. Dr. Issei Yamamoto has pointed out that an error has occurred regarding the place of discovery. Okabayasi is at Kurasiki Observatory, which is under the direction of Yamamoto, and early in the morning of September 30 he discovered the object in Leo, suspecting its cometary character at the time, though he was not able to confirm its motion until October 4. Honda is at the Zodiacal Light Station at Seto, Hirosimaken, also under the supervision of Yamamoto, and independently discovered the comet on October 4. From his long experience as an observer he was immediately convinced that it was a comet and reported his discovery to Yamamoto, who met both observers at Kurasiki on October 5 and cabled to Copenhagen. A telegraphic announcement was also made from Tokyo Observatory, and it is possible that some confusion was caused by this. It is very satisfactory to know that the Astronomical Society of the Pacific has awarded the Donohoe Medal to both discoverers.

Announcements

PROF. LANCELOT HOGBEN, F.R.S., regius professor of natural history in the University of Aberdeen, has been appointed Mason professor of zoology in the University of Birmingham in succession to Prof. H. Munro Fox (see NATURE, June 28, p. 800).

Dr. L. L. Bircumshaw has been appointed lecturer in inorganic chemistry in the University of Birmingham.

THE Minister of Agriculture and Fisheries has appointed the Hon. Mrs. Youard to be an additional member of the Committee set up on July 21, under the chairmanship of Lord Justice Luxmoore, to examine the present system of agricultural education and to make recommendations for improving and developing it after the War (see NATURE, August 9, p. 161).

AT the recent annual meeting of the U.S. National Academy of Sciences, a National Science Fund was established to administer funds for the support of scientific research. The Fund will be managed by a committee under the chairmanship of Dr. William J. Robbins, director of the New York Botanical Gardens, and consisting of seventeen members of the National Academy and twelve others well known in public life or industry.

THE report of University Extension Lectures and Tutorial Classes of the University of Leeds, for the year 1939–40, is a record of steady progress under adverse conditions arising from the War. In all, 78 tutorial classes and 5 sessional courses were attended by 1,063 students. The great majority of the lecture courses dealt with such subjects as literature, social philosophy, economic and political questions and current movements of the day. Of scientific subjects seven courses were held in biology, three in psychology and one each in physiology and geology. The marked absence of any lectures dealing with the physical sciences remains as a challenge to men of science to present their subject in a form acceptable to an ordinary unselected adult audience.

IN accordance with the trust deed governing the Harrison Memorial Fund, the Selection Committee consisting of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, will make an award of the Harrison Memorial Prize in December. The Prize, of the value of about £150, will be awarded to the chemist of either sex, being a natural born British subject and not at the time more than thirty years of age, who during the previous five years has conducted the most meritorious and promising original investigations in any branch of pure or applied chemistry and published the results of those investigations in a scientific periodical or periodicals. Further information can be obtained from the Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1.

ERRATUM.—In a recent communication (NATURE, 148, 226; Aug. 23, 1941) the dissociation products of carbon dioxide were given as $CO(^3\Omega)+O(^3P)$. This was a printer's error and should read $CO(^3\Pi)+O(^3P)$.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Post-mortem Darkening of Plant Tissues and its Relation to Respiration

THE darkening of plant tissue following extensive mechanical damage is a frequently observed phenomenon and is due to irreversible oxidation of polyphenols. The effect is particularly well marked in the tea-leaf, where the tannin oxidation results in the development of the characteristic copper-red colour of 'fermented' tea-leaf.

It is possible to effect a full fermentation of tea-leaf, that is, a complete oxidation of all the tannins present, while still preserving the cellular nature of the tissue. After fermentation, following extensive mechanical damage, the cell walls are largely intact; and it is observed that the tannins are no longer localized in the vacuoles but are distributed throughout the whole tissue. It follows that rupture of the outer cell wall is not essential for irreversible oxidation of tannins to take place.

The necessary damage to the tea-leaf is best achieved by subjecting the wilted leaf to a shearing force such as is obtained by rubbing it between the finger and thumb or between the palms of the hands. While such treatment has but little effect on the integrity of the outer cell walls, it has been claimed by Phillis and Mason[1] that comparatively small shearing forces have a disruptive effect on the continuous phase of the cytoplasm.

The effect of such shearing forces on the respiratory activity of the leaf is marked. The capability of undergoing anaerobic fermentation may be almost completely inhibited[2] and oxygen uptake under aerobic conditions is also suppressed unless an oxidizable polyphenol is present[3].

Results to be presented shortly interpret this effect in tea-fermentation as due to coenzyme inactivation. The disruptive effect on the cytoplasm may be considered as affecting the orientation of molecules in protein-phosphatide monolayers where adsorption of coenzymes I and II is a necessary adjunct to the transfer of hydrogen from respiratory substrates to carriers of the cytochrome type. The effect of the destruction of the organization of such monolayers will be to inactivate the coenzymes by restricting their sites of activity, and hence to reduce respiratory activity to low levels. If the vacuole originally contained appreciable amounts of polyphenols, these latter substances may now penetrate into the cytoplasm where they undergo direct oxidation by the oxidase system to form deeply coloured pigments. Until this oxidation is complete, the tissue may consume oxygen at a rate higher than that when undamaged, but when the polyphenols are oxidized the uptake sinks to the same low levels found for tissues free from polyphenols. The respiratory quotient during the rapid oxygen uptake is low.

There are other means of inducing irreversible oxidation of polyphenols in vegetable tissues including treatment with anæsthetics such as chloroform, and subjecting the leaf to a temperature of about 50° C. In both these cases it is observed that the cytoplasm is rendered freely permeable to the vacuole contents. Further, the solvent effect of the chloroform on the phosphatides or the denaturing effect of the elevated temperature may be expected to result in a destruction of the organization of protein-phosphatide monolayers fully equal to that brought about by shearing forces.

The effects of anæsthetics, moderate heat and mechanical damage involving shearing forces on the respiratory activity of vegetable tissues are therefore to be considered as essentially similar. Enzyme inactivation is not responsible for the diminution in respiratory activity, and the effects are to be interpreted as due to the inability of the coenzymes to couple the oxidase system and dehydrogenases in the disorganized tissue. Polyphenols present in the vacuole may then penetrate into the cytoplasm to undergo oxidation catalysed by the oxidases. Some secondary oxidation of respiratory substrates by the *o*-quinones may be brought about through the coenzymes now in homogeneous solution, but the respiratory quotient values observed (0·2–0·5) for different plant tissues indicate that the greater part of these *o*-quinones undergo further irreversible changes, with pigment production, before being able to function as hydrogen acceptors in this way.

E. A. HOUGHTON ROBERTS.

Indian Tea Association,
Tocklai, Cinnamara P.O.,
Assam.
May 6.

[1] Phillis and Mason, NATURE, 140, 370 (1937).
[2] Deb and Roberts, *Biochem. J.*, 34, 1507 (1940).
[3] Roberts and Sarma, *Biochem. J.*, 34, 1517 (1940).

Blackening of Potato Tubers on Boiling

IT might be of interest to state one or two facts which may have some relation to the hypothesis advanced by Miss Ursula M. Robison[1], that the blackening of potato tubers on boiling is caused by the black oxide of iron produced by oxidation from ferrous iron liberated from a loose complex, probably in association with proteins, as the result of hydrolysis on boiling.

From an examination of potato samples derived from about forty modern replicated fertilizer experiments, designed in association with Dr. E. M. Crowther of Rothamsted Experimental Station, I found that the typical grey to black discoloration which develops after boiling was confined to tubers grown on potash-deficient plots in association with a relatively high nitrogen level in the soil.

It has been shown by various workers that in potash-starved plants the amino acids increase relatively to the protein, and it has been suggested that this is due, at least partly, to the breakdown of protein in the prematurely ageing plants. These changes may cause an abnormal distribution of iron in potash-deficient plants and produce a greater concentration in potato tubers. Hoffer[2] has shown that

maize plants grown under conditions of potash deficiency do accumulate iron compounds in the node tissue and that the tissue develops a dark purplish-brown coloration and breaks down. He actually developed from this observation a method of diagnosing potassium deficiency in the soil, based upon the application of an acid solution of potassium thiocyanate to the nodule tissues of corn stalks when cut open lengthwise.

It would have been interesting to know whether Miss Robison found any significant differences in the potassium content and in the potassium-iron ratios between normal tubers and those that went black after boiling.

G. A. COWIE.

Sauncey Crook,
Sauncey Avenue,
Harpenden.
Aug. 15.

[1] NATURE, 147, 777 (1941).
[2] Purdue Univ. Agric. Exp. Sta., Bull. 298 (1930).

Vitamin C Content of Fresh, Canned and Dried Guavas

THE common guava, *Psidium guajava*, has not as yet received the recognition which it deserves as a potent source of ascorbic acid. Both in Hawaii[1] and in India[2], values as high as 300 mgm. per 100 gm. have been reported for the fresh fruit, although many lower values are to be found in the literature.

We have investigated the vitamin C content of guavas from various parts of the Transvaal and the Cape Province. Ascorbic acid has been estimated by titration with indophenol in aqueous or dioxane solution, after extraction of the material with a 2 per cent solution of metaphosphoric acid. Canned guava juice has been assayed biologically by Key and Elphick's modification of the Hojer tooth method, the results being in agreement with those found by the chemical method.

Condition of fruit	Ascorbic acid content in mgm. per 100 gm.
Green and hard	250–350
Ripe and firm	300–450
Over-ripe and soft	50–100

In the above table is summarized the variation of vitamin C content of the fruit as a whole with its condition. It will be seen that the amount of ascorbic acid present in the fruit increases as it ripens but soon diminishes as the guava becomes soft. Firm fruit of high vitamin content may be stored at room temperature for several weeks without serious loss of vitamin but where the guava is ripe or infected with fruit fly the value decreases rapidly.

There does not appear to exist a wide variation in the vitamin content of fruit of different varieties or from various districts. On the whole, however, white-fleshed guavas are usually slightly richer in ascorbic acid than those with pink flesh.

Of the different parts of the fruit, the skin has the highest content, the inner pulp contains little, and the stones none at all. The proportion of ascorbic acid found in skin, outer pulp and inner pulp may be as high as 12 : 5 : 1.

When selected firm fruit is canned the ascorbic acid present in fruit and juice reaches levels of 200–300 mgm. per 100 gm. The use of soft fruit is attended by a sharp decrease in the vitamin content, values as low as 18 mgm. per 100 gm. being found in some cases. These low values also obtain under conditions favourable to the oxidation of the vitamin such as pulping or overcooking.

The most successful procedure for the preservation of the vitamin has been found by us to be drying at low temperature. The unpeeled fruit is quartered, the central pulp and stones removed and the residue blanched for two minutes. Thereafter the fruit is dried at 130° F. for 10–12 hours and powdered. Powdered guava prepared in this manner contains 2,500–3,000 mgm. per 100 gm. (white) and 2,000–2,500 mgm. per 100 gm. (pink). Failure to blanch the fruit prior to drying results in lower values (1,000–1,500 mgm. per 100 gm.). Thus dried guavas compare favourably with other rich sources of the anti-scorbutic vitamin such as dried rose hips, reported by Lund, Spur and Fridericia[3] to contain 2,000 mgm. ascorbic acid per 100 gm. Moreover, the guava powder has a pleasant aromatic odour and practically no taste.

The above results, taken in conjunction with the wide distribution of the various species of guava and the ease with which they can be grown, justify their extensive cultivation and consumption. Full experimental details will be published later.

We wish to express our appreciation of the assistance and co-operation accorded us by officers of the Food Inspectorate (Q Service-Supplies) and the Mobile Laboratory Unit of the South African Medical Corps.

LEON GOLBERG.
South African Institute for Medical Research,
Johannesburg.

LEOPOLD LEVY.
Government Chemical Laboratories,
Johannesburg.
July 12.

[1] Miller, C. D., Bazore, K., and Robbins, R. C., Hawaii Agric. Exp. Stat., Bull. 77 (1936).
[2] Ranganathan, S., *Ind. J. Med. Res.*, 23, 239 (1935).
[3] Lund, H., Spur, B., and Fridericia, L. S., *Biochem. J.*, 28, 1825 (1934).

Intergranular Changes in an Iron Alloy

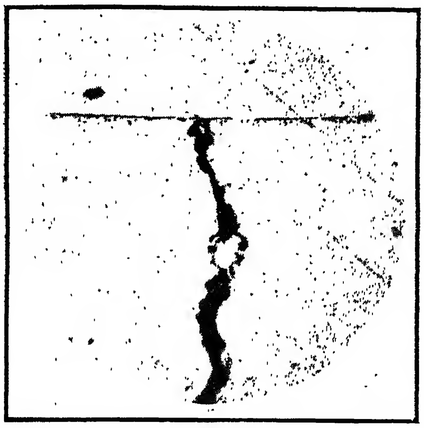
THE phenomenon of intercrystalline attack by liquid metals on solid metallic crystalline aggregates is well known[1], but the recorded cases which we have been able to find are chiefly of the attack of low-melting metals such as tin, solder, lead and cadmium on high-tensile steel, and mercury on copper, nickel and aluminium alloys.

An example has now been met of attack by mercury on high-tensile steel. The steel is of the following analysis and mechanical properties.

Analysis		Mechanical Properties	
C	0·28–0·32 per cent		
Ni	3·75–4·5 ,,	Ult. stress.	c. 105 tons/sq. in.
Cr	1·0 –1·5 ,,	El	c. 14 per cent on 4 $\sqrt{A}$
Mo	Nil	Red. of area	25 per cent min.
Mn	c. 0·60 ,,	Izod value	c. 25 ft.lb.
S	below 0·04 per cent		
P	,, ,,		

The above mechanical properties are obtained by air-hardening. In a certain application an oil-hardened nickel-chrome steel dowel pin *W* in. diameter is pressed into a hole in this air-hardening steel with a slight interference fit – 0·0001–0·0002 in. A series of failures in service was met. In every instance the fracture had two easily distinguishable zones—an initial zone exhibiting what appeared to be brittle fracture and a secondary zone of well-marked fatigue type spreading from this. Microscopic

sections across the two zones showed no defects in the steel adjacent to the fatigue fracture, but the initial zone invariably showed break-up at the edge of the fracture which was connected with intercrystalline boundaries.



× 250.

Heat treatment, internal stress and mechanical factors were exhaustively explored and the whole workshop process of manufacture overhauled and improved, but no constructive light could be thrown on the problem until it was discovered that one of the operators engaged in making the parts used on occasions a 'mercury ointment' as an aid to fitting the dowels. This ointment is known by pharmacists as Ung. Mercuriale B.P.C. Its use as a lubricant is mentioned in some cheap popular handbooks of engineering, especially for tapping holes in difficult steel, easing tight fits, etc.

Special specimens incorporating a driven-in pin were fitted with the ointment between the surfaces, controls fitted dry being used. Specimens and controls were subjected to reversed bending on a Wöhler type of fatigue-testing machine. Specimen and control were run on the same machine simultaneously. Triplicate tests were made. In two cases intercrystalline attack as shown in the accompanying illustration occurred. In the remaining case early fracture occurred for mechanical reasons connected with the shape of the specimen.

Static tests were carried out by loading a specimen in tensile at 75 tons/sq.in. after amalgamating mercury on its surface. Brittle failure with intercrystalline attack occurred after 36 hours. A specimen without mercury withstood three weeks at 75 tons/sq. in without failure and five days at 90 tons/sq. in. without failure.

The withdrawal of the ointment from the workshops has up to the time of writing and over fourteen months stopped the failures.

It will be seen, therefore, that this seems to be a genuine case of intercrystalline breakdown of high tensile steel caused by the presence of mercury.

E. Wood.
S. T. Harrison.

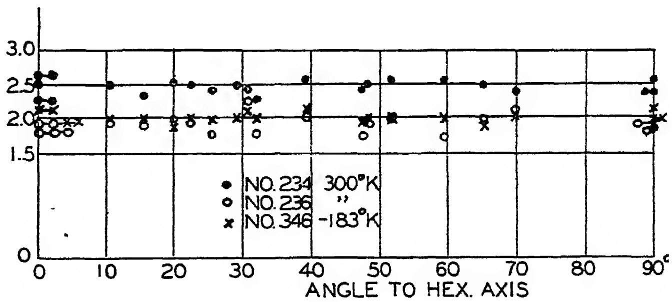
Armstrong Siddeley Motors Limited,
Coventry. July 25.

Dickenson, J. H., *J. Inst. Met.*, 24 (1920); van Ewijk, L. J. G., *J. Inst. Met.*, 56 (1935); Hartley, H. J., *J. Inst. Met.*, 37 (1927). See also discussion on van Ewijk's paper. There are many other references.

Electron Diffraction Intensities

Under this title, Fordham[1] has discussed the intensity anomalies observed by us in the electron diffraction pattern of zinc oxide. Fordham believes that "variations in extinction due to irregular crystal shape or to anisotropy will explain at least qualitatively many of the observed differences between calculated and observed electron diffraction intensities".

We have considered this possibility ourselves and have discussed it in some detail[2]. Such an effect as we pointed out would have to be dependent on electron energy. However, in the whole range 7–80 kv., no noticeable difference in the intensity distribution of the pattern has been observed, and therefore one must conclude that absorption does not account for the anomalies observed. Several years ago L. Pauling, in discussing this point, raised the question of the influence of the distribution of crystal size in the specimen. He pointed out that it might be possible that the absorption factor could be reduced to a product of a purely geometrical factor, depending on (hkl), and an absorption factor which remains the same for all planes. In this case no dependence on voltage is to be expected for the relative intensities. Calculations by Yearian with a suitable particle size distribution have shown that such a formulation is possible, but that the change in intensity obtained in this way would be too small to reproduce the observed anomaly. It is correct that the form of the zinc oxide crystallites consists partly of very thin filaments. However, the difference in sharpness of the $(00{\cdot}1)$ as compared with the $(hk{\cdot}0)$ diffraction lines is only an apparent one. In the many micro-photometer traces taken in our work, the half-widths for the lines, corrected for background, do not show any appreciable variation as a function of the angle with the Z-axis.



Half-widths in mm. plotted against (hkl), the planes being arranged as a function of angle with the Z-axis

However, the most cogent proof of our hypothesis is found in the fact that it is possible to reproduce the main features of the electron diffraction pattern by determining the F factor with X-rays experimentally, and constructing the corresponding Z–F curve for the electron diffraction pattern[3]. This is also substantiated by the calculations of Johnson and James[4], who show that it is possible to account for this anomaly by assuming a distortion of the valence electron cloud. Some of the minor details of the diffraction pattern may very well be influenced by some second order effect, such as absorption or extinction or temperature-dependency, but the main features are reproduced by the distortion of the electron cloud.

As to the case of evaporated metal films, there is also considerable deviation from the calculated intensity, as we first pointed out some years ago[5]; these anomalies have now been reproduced by Ornstein and collaborators[6]. Therefore a full explanation cannot be made on some such simple assumption as difference in the shape of crystals or different absorption in different direction. Some other effects such as distortion of the electron cloud and dynamic effects of reflexion have to be taken into account.

K. Lark-Horovitz.
H. J. Yearian.

Department of Physics,
Purdue University,
Lafayette, Indiana.
August 7.

[1] Nature, 146, 807 (1940).
[2] *Phys. Rev.*, 48, 631 (1935), particularly p. 634.
[3] See Lark-Horovitz and Ehrhardt, C. H., *Phys. Rev.*, 57, 603 (1940).
[4] *Phys. Rev.*, 53, 327 (1938); 56, 119 (1939); 57, 613 (1940).
[5] *Proc. Amer. Phil. Soc.*, 76, 5 (1936); *Phys. Rev.*, 48, 381 (1935).
[6] *Physica*, 5, 693 (1938); 7, 685 (1940).

Social Functions of Science

In recent discussions on the social functions of science not every contributor has escaped the pitfall of confining the role of science to improving material conditions. I venture to offer the following as a restatement of the more fundamental social function, which is presupposed by the purely material function.

The pursuit of natural science may be regarded as a type or microcosm of all rational life. For, first, scientific work employs reason working upon sensible experience; it requires careful seeking of evidence, and constructive interpretation thereof; and consequently demands respect for fact, for logic, for insight and for imagination. Second, it exhibits a rational unity of thought and action, in the continual interplay of experiment and theory. Third, it is a social as well as a personal enterprise; as such, it demands respect for the human person and tolerance for diverse opinions, and favours a mental climate which is a balance of appreciation and criticism. It would not be difficult to work out in greater detail the rôle of natural science as a representative type of rational behaviour. All the above characteristics are to be observed also in the running of a business, a farm, or a family, or in any rationally conducted enterprise. The special methods used, and the results, are different in each case, but the spirit defined by these characteristics is common. Moreover, natural science prepares the mind for other rational disciplines, including metaphysics and ethics, which likewise employ both reason and experience; it shares with them the rational spirit, though dealing with a more restricted aspect of experience.

Now natural science, through its influence on daily life, is becoming for many the most easily recognized form of rational behaviour. Further, so long as it remains alive at all, it cannot fail to exhibit rational standards; false science is easily detected by experiments accessible to all men of science, and moreover, would lead to failures if applied. The most menacing fact of the present time is that the fundamental principles of respect for truth and for the human person (integral elements in the culture bequeathed to us by Christendom) are not everywhere recognized. In the intellectual chaos of our times, natural science may therefore be an important influence in holding many to rational standards. If men will carry the *spirit* learned in pursuing natural science into other and more personal activities (without trying to carry over also the special methods of natural science into fields which are much too subtle and too complex for them), we may hope for a more rational world.

The influence of science in this way is no less important than in providing the technique for changing the material conditions of life—indeed it is infinitely more important, since the wise application of science requires *direction*, which cannot be provided by natural science itself, but only by ethical science and insight. Whether men of science should try to undertake this direction, or whether this social function does not rather stop at propagating the spirit of rational living, is another argument.

E. F. Caldin.

Queen's College,
Oxford.
August 12.

Social Education in the Services

Among the three thousand lecturers to the Forces included in the panels of our twenty-three regional committees there are many who offer one aspect or another of science as their subject. The choice of lecturer and topic is, under the agreement made by the Central Advisory Council for Adult Education in H.M. Forces with the Services, dependent upon the expressed wishes of the men and women themselves. It is the function of the Service education officers to ascertain what these interests are. A considerable number of lectures on scientific subjects and classes in either pure or applied science have been provided. The resources of the universities, local education authorities and voluntary bodies have been placed fully at the disposal of the Services for this purpose.

The article in Nature of August 16, p. 173, appears to overlook the existence of all this co-operative activity on the part of the Services and the civilian educational bodies. It might perhaps surprise the writer to learn that on the estimate of the Director of Army Education, a million men and women in the Army attended lectures in the course of a recent month. The demand for educational facilities of all sorts has been maintained right through the summer and may well develop still further during the coming autumn and winter. At a recent conference of regional committee secretaries it was agreed that scientific subjects ought to take a larger place in the programme; but it was pointed out that those who offer them do not always present either attractive titles or an exposition which makes scientific facts and theories relevant to the interests and the thought of ordinary men and women. From this point of view the suggestions made in the article are particularly valuable and I hope that they will be very widely followed by lecturers, actual or potential, to the Forces.

Basil A. Yeaxlee.

Central Advisory Council for Adult Education
in H.M. Forces,
Rewley House, Wellington Square,
Oxford.
Aug. 23.

ELECTRICAL DEVELOPMENTS IN MADRAS

IN a paper published in the *Electrician* of August 1, by J. Meek, the resident electrical engineer to the Madras Presidency, interesting projects are suggested about new developments in the Madras Presidency. This Presidency covers an area in South India of 142,000 square miles and supports a population of about 48 millions. An idea of the size may be obtained by comparison with that of England, which has an area of about 50,000 square miles and a population of about 38 millions. The people in the Presidency are mainly engaged in agriculture, and most of them live in villages. The capital, Madras City, has a population now approaching 800,000, but the next biggest town, Madura, has a population of less than 250,000. Four main languages are spoken—Tamil, Telugu, Canarese and Malayalani—and efforts are now being made by the Congress Government to introduce Hindi with the ultimate object of providing India with a common language. Among the educated classes English is widely spoken.

Some idea of the climate of Madras can be obtained from the following significant clause which usually appears in Madras Government electrical specifications: "The temperature in the shade will vary from 50° F. to 110° F. The max. temperature in the sun may be assumed to be 150° F. The relative humidity will vary from 60 to 80 per cent."

Although for the greater part of the year there is very little rain in most parts of the Presidency, there is considerable rainfall during the south-west and north-east monsoons, especially in the eastern and western Ghats, where more than 400 in. is registered in some places.

Until comparatively recently the only supply system of any importance was that of the Madras Electric Supply Corporation, which has held a licence from the Government for the generation and distribution of electricity in Madras City for the last thirty-one years. This Corporation has a steam-turbine power station with a capacity of more than 53,000 kva. The Presidency has no coal or oil deposits but is fairly well provided with water-power in the south. In 1924 the Madras Government decided to take charge of all hydro-electric surveys and projects and bought back concessions previously granted to private concerns which had not been developed.

The Pykara Scheme in the Nilgiri Hills was taken up first. It is situated at a distance of 280 miles to the south-west of Madras. Pykara is a high head scheme with storage utilizing a fall of 3,000 feet. When the great Mettur Dam was built some years ago for irrigation control, hydro-electric pipes were left ready in the dam, and this development was the next to be taken up about five years ago. The present installed capacity of plant is 37,500 kva. operating on a head which varies from 60 to 160 feet. In addition to these schemes the Madras Government has provided two steam stations in the north. There are many miles of feeder lines and also a considerable mileage of 33 kv. and 11 kv. The length of these transmission lines has necessitated the introduction of synchronous condensers at Trichinopoly and Madras.

The demand for power has greatly exceeded the most optimistic estimates, and additional plant and extensions to lines and substations had to be installed several years in advance of the original programme.

The grid supplies power direct to many tea factories, ginning factories, oil mills, chemical works, and even to farmers in outlying districts. More than a thousand small pumping sets are connected to the systems for pumping water from wells into the fields. The ryot has found it cheaper and more convenient to water his fields by means of electricity than by using bullocks as his forefathers have been doing for centuries.

UNIVERSITY OF THE WITWATERSRAND

NEW ENGINEERING BUILDING

ON June 18 at the University of the Witwatersrand, Johannesburg, General the Right Hon. J. C. Smuts, Prime Minister of the Union of South Africa, opened the new Wolf and Hirsch Hillman Building, which forms an important and substantial addition to the accommodation provided for instruction in engineering. Its site, lying to the west of the central block and south of the older engineering block, stands higher than these, and in its lay-out this has been utilized to permit of the formation of terraces and rock-gardens and the provision in an economical manner of a range of garages.

The building consists of two wings running east and west, the larger, about 210 ft. long, being devoted to laboratories and placed on the north side so that it receives the maximum light. The shorter south wing, about 130 ft. in length, provides accommodation for a model analysis laboratory, drawing halls and lecture theatres. The east wing connecting these other two contains the entrance hall and staff offices.

The Department of Civil Engineering provides a four-year course for the degree of B.Sc. (Engineering) which is recognized by the Institution of Civil Engineers as exempting its holders from Sections A and B of its associate membership examination. In the Union, it offers a qualification for those entering the higher technical services of the Irrigation and Public Works Departments, National Road Board, South African Railways and Harbours and other equally important administrations and undertakings.

The new Hillman Building will greatly enhance its facilities by providing spacious and well-equipped laboratories with workshops and stores and ample accommodation for lectures. It has been designed to serve a threefold purpose: (i) to promote the course of training already referred to; (ii) to provide for research into fundamental problems of civil engineering; and (iii) to assist in the solution of problems arising in practice.

The main features of the Hydraulics Laboratory are a level flume, 3 ft. wide, 2 ft. 6 in. deep, with an overall length of 82 ft. and glass sides to allow of easy observation; a smaller flume with one end capable of being given a maximum tilt of 1 in 20; a river model table 10 ft. wide and 70 ft. long for the study of river and tidal flow; and a general purpose bench for experiments on the flow of water in pipes.

In the Structures Laboratory, a 350,000-lb. precision hydraulic testing machine has been installed for compression and bending tests. This is fitted with an automatic loading device giving ten different rates of loading and reading to the nearest 10 lb. A 75,000-lb. machine for tensile tests and permitting of compression and bending tests on short struts and beams is on order and will have autographic load-deformation recording apparatus. There are also several test-beds for testing members and structures, and the accessories provided are of the latest types.

The investigation of structural problems by various methods of mechanical analysis employing small-scale models will be carried out in the Model Analysis Laboratory, the equipment of which includes a Continostat apparatus for the experimental determination of influence lines using spline models and a Lobban deformeter. In the Highway Engineering and Materials of Construction Laboratory the main space has been divided into three sections: (1) tar, bitumen and asphalt; (ii) soils and aggregates; (iii) cement and concrete. Each has been suitably provided with apparatus and equipment which will enable tests and investigations to be carried out in conformity with present-day practice in this field, in which there is so much scope for development.

IRISH SALMON, SEA TROUT AND EELS

THE Fisheries Branch of the Irish Department of Agriculture has published a brief summary of the catch of salmon, sea trout and eels in Eire between 1927 and 1939*. Alternate years only are given, the figures are neither averaged nor compared, and no comments are made or inferences drawn. But the statistics themselves are of no small interest, as the following epitome of part of them is enough to show.

	1927	1929	1931	1933	1935	1937	1939
Salmon							
Total catch (wt.)	100	48	75	68	78	45	46
do. rod only	100	24	53	31	50	38	34
Average wt. per fish (lb.)	12·9	13·5	9·7	11·8	9·8	10·7	10·2
	100	105	75	91	76	83	79
Value per rod (shillings)	189	77	85	66	84	69	72
	100	41	45	40	49	37	38
Sea Trout							
Total catch (wt.)	100	101	101	91	100	96	101

The period is not long enough, nor the data complete enough, to let us speak of any lasting *trend*; but it is clear that the catch of salmon has greatly diminished of recent years. Since 1927, the annual catch (as shown in alternate years) has never reached 80 per cent, and has three times out of six been less than 50 per cent, of that year's catch. The catch by rod is worse still; for it has been so low as a quarter, and has only once been more than a half, of the catch of 1927. On the other hand, the catch of sea trout, while it has its ups and downs in the various rivers, averages out over all to a nearly constant total, year by year.

More remarkable than the diminished catch of salmon is a diminution in the average weight of the same fish. From 1931 onwards the average weight has been much below that of 1927–29; and in the last five annual periods it has only averaged about four-fifths of the weight in the first two.

The returns from the several rivers or fishery districts show many interesting things. We have seen that the salmon catch of 1939 was only 46 per cent of that of 1927; but the decrease, though it extended well-nigh all round the coast of Eire, was very far from uniform. The three contiguous east coast districts, Dundalk, Drogheda and Dublin, had in 1939, 90, 99 and 90 per cent of the catch of 1927; but the next succeeding regions, on the south-west and south coasts, namely, Wexford, Waterford, Lismore, Cork and Bandon, show only 34, 38, 26, 21 and 19 per cent, in the same comparison. The commercial importance of all these statistics is, as usual, the least interesting part of them. D. W. T.

* Eire: Roinn Talmhaidheachta (Department of Agriculture), Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1939, 1937, 1935, 1933, 1931, 1929, 1927. (P. No. 4658.) Pp. 20. (Dublin: Stationery Office, 1941.) 6*d*.

ELECTRIC STRENGTH OF SOLID DIELECTRICS

IN a paper, by W. G. Standring, of the National Physical Laboratory, which is published in the Power Engineering Section of the *Journal of the Institution of Electrical Engineers*, of August, a discussion is given of the behaviour of a number of insulating materials under disruptive voltages. Experiments were carried out with the object of filling large gaps in our knowledge in a field which has only been partially explored. At the present time, a knowledge of electric strength is of twofold interest. It is of fundamental importance to the engineer, and values of electric strength should provide guidance to the mathematical physicist in developing theories to explain the mechanism of electric breakdown.

Measurements of the electric strength of solid dielectrics have been made on samples up to a few millimetres in thickness. The values obtained are of the same order as those maintained on thin samples under maintained voltages. They indicate that a solid dielectric has a characteristic strength or gradient which causes breakdown, independent of thickness and not greatly dependent on the rate of application, or on the duration of the stress. Continental physicists have formed a similar conclusion for liquids.

Secondary phenomena such as surface discharges and thermal effects are more easily eliminated under impulse conditions than under sustained voltages, since short time limits the production of effects such as the generation of heat, and because a wider range of liquids exists for the selection of a satisfactory immersion medium. In measuring the electric strength or gradient which causes breakdown of solid dielectrics, an immersion medium is necessary to avoid flash-over; also breakdown must not occur first in the medium of the electric field applied to the material under test, as the field is then disturbed and deduction of the breakdown stress from the applied voltage and the geometric configuration becomes impossible. It is not usually practicable to embed electrodes in a solid dielectric in such a way that only the material under test is stressed.

In general, gases have lower electric strengths than liquids and liquids than solids. Discharges may therefore occur in the surrounding medium before the breakdown gradient of the material under test is reached. These discharges act as pointed extensions of the electrode with high concentration of stress at their tips, and the solid test material may break down owing to the local incalculable stress or on account of the high local temperature of the discharge. It is therefore necessary to avoid discharges in the immersion medium. Glycerine has been found to be a suitable immersion medium for testing many dielectrics at atmospheric temperatures under impulse voltages.

Mr. Standring points out that in forming physical theories of the mechanism of breakdown, experimental data on crystalline materials such as mica are likely to be of most help. When maximum results were used, the highest value obtained on the thinnest light amber was nearly the highest obtained with the best mica, which was the same at all thicknesses. For purposes of physical theory, therefore, it may be desirable to take the highest experimental values obtained rather than the average value.

ACCRETION THEORY OF STELLAR EVOLUTION

BEFORE the advent of the accretion theory of stellar evolution, physical theory had progressed sufficiently to suggest the transmutation of hydrogen as providing practically all the stellar energy. Astronomical evidence, especially from double stars, led to the view that there must be a further potential source of energy from outside the stars which replenished the hydrogen in the stars. The existence of interstellar matter in gaseous form in certain regions of the galaxy was known but this knowledge did not simplify the problem. The chief constituent of the cloud was regarded as calcium, and possibly other similar elements such as sodium were also present, but accretions from such elements would merely increase the mass of the star and would not prolong its life.

The subject is dealt with in a recent paper by Messrs. F. Hoyle and R. A. Lyttleton (*Mon. Not. Roy. Astro. Soc.*, **101**, 4, 227), though most of the authors' work has been published elsewhere[1] on different occasions. In their discussion of the problem they postulate the presence of a hydrogen cloud and then consider the conditions which such a cloud must satisfy. The formula arrived at for the rate of change of mass when the motion has become steady is

$$\frac{\partial M_A}{\partial t} = 18\gamma^2 M^2 \rho / \bar{v}^3,$$

where ρ is the density of the cloud in the neighbourhood of the star, M the mass of the star, γ the constant of gravitation and $\bar{v}$ the relative velocity of the star and cloud appropriately averaged to allow for the motion of the star in the galaxy.

Three hypotheses are stated as the requirements of the accretion theory formulated by the authors:

(*a*) That the cosmical cloud in its regions of highest density contains an appreciable proportion of hydrogen molecules—10 per cent by mass would suffice;

(*b*) That the cosmical cloud is not everywhere evenly distributed but possesses local small irregularities;

(*c*) That the cosmical cloud is irregularly distributed also on a large scale, and in particular it is strongly concentrated towards the galactic plane, where the density rises to the value of order 10^{-21} gm. per c.c.

In the solution of the problem of the source of energy of the bright stars the authors invoked a hypothesis which, they claim, has also solved the question of the dynamical evolution of binary stars, and hence the new process has unified the dynamical and physical evolution of stars. In the accretion process no question of a mechanism unknown to science is introduced and thus speculation is almost entirely absent in the theory—a remark that cannot be applied to other theories, for example, that of the complete annihilation of matter. Nevertheless if, as is possible, future investigation should disprove one or more of the three hypotheses previously referred to, the theory would require considerable modification or it might be necessary to abandon it.

Evidence is cited to show that there is support for the hypotheses. Thus, (*a*) requires an appreciable proportion of the cloud to be in molecular form, and Adams and McKellar have recently found the occurrence of vibrational-rotational transitions in the molecules CH and CH in the cosmical cloud. The hypothesis (*c*) may be doubted by many, but one very interesting result follows from the asumption, which is confirmed; namely, that the most massive and luminous stars should be concentrated to the galactic plane. As this agrees with observation a result is obtained for which theoretical astronomy has not previously been able to give any adequate explanation.

Many objections have been urged by Atkinson[2] and these are dealt with in the paper, but limits of space forbid a detailed consideration of these. One, however, is worth noticing. Atkinson considers that a density 10^{-21} gm. per c.c. near the galactic plane is too high. It is interesting to notice, however, that Jeans has obtained central densities of the order 10^{-21} for a number of extra-galactic nebulæ of the spiral type, and the objections could not apply to stars situated in

these external galaxies. Objections relating to the high rate of increase of mass given by the formula, the difficulties regarding the time-scale, the lack of any observable distinction separating stars of small velocity from those of slightly higher velocity, etc., are considered by the authors who, if they have not established their theory, have indicated certain lines along which investigations should be conducted. Reliable observations which supply information of the density distribution and velocities of the stars relative to the cloud will confirm, modify or disprove the theory.

[1] See *Proc. Camb. Phil. Soc.*, **35**, 405, 592 (1939); **36**, 325, 424 (1940); and also NATURE, **146**, 97 (1940) with earlier references.

[2] *Proc. Camb. Phil. Soc.*, **36**, 313 (1940); *Mon. Not. Roy. Astro. Soc.*, **100**, 500 (1940).

FISH OILS

PRIOR to the War, the fish oil industry was successfully applying to problems of production the results of recent research, particularly with respect to vitamins A and D. The liver oils from some species possess extraordinary potency, thus the blue-fin tuna or horse mackerel yields oil containing up to 400,000 I.U./gm. of vitamin A and 60,000 I.U./gm. of vitamin D as compared with 800 I.U./gm. (A) and 100 I.U./gm. (D) for average cod liver oil. The soupfin shark liver contains 40–70 per cent of oil the vitamin A potency of which is frequently more than 100,000 I.U./gm., but on the other hand it is very poor in vitamin D, the potency being only about 20 I.U./gm. This oil is produced on a large scale in California at relatively small cost, and is probably the cheapest source of vitamin A in a highly competitive market.

The discovery in 1937[1] that oils extremely rich in vitamin A can be obtained by extracting the intestines of fish like halibut, has been followed up commercially on the Pacific Coast, but the nature of the raw material demanded modifications in technique. These have been kept secret. According to Brocklesby[2] 126,000 dollars worth of halibut livers and 37,000 dollars worth of intestines were landed at Prince Rupert, B.C., in 1938. In 1939, 3,853 cwt. of halibut livers yielding 650 gal. oil compared with 688 gal. visceral oil were produced in British Columbia. Fishing for halibut in the Pacific is regulated by an international agreement between Canada and the United States, and the annual quota is about 46 million lb. of which about a quarter is landed in Canada. The viscera account for about 2 per cent of the weight of the fish and the oil content (1–5 per cent) is low. The vitamin A potency is, however, usually two or three times greater than that obtained from the liver. The characteristics of commercial halibut visceral oil are given in detail by Brocklesby and his colleagues.

The viscera from various species of salmon yield a few per cent of oil containing usually more than 5,000 I.U./gm. and 100 I.U./gm. of vitamins A and D respectively. Very large quantities of oil are extracted from salmon cannery waste and the commercial salmon oil is of considerable value for poultry feeding, as well as having other important uses.

[1] Lovern, Edisbury and Morton, NATURE, **111**, 234, 276.

[2] "The Chemistry and Technology of Marine Animal Oils with particular reference to those of Canada", Bull. 59, Fisheries Research Board of Canada, 1941.

PLANKTON STUDIES

IN two important papers, Gordon A. Riley continues his investigations on the interaction of the plankton with its environment ("Plankton Studies. 3. Long Island Sound", *Bull. Bingham Oceanograph. Coll.*, Peabody Museum of Natural History, Yale University, 3, Jan., 1941. "Plankton Studies. 4. Georges Bank", *ibid.*, June, 1941). The preceding work ("Plankton Studies" 1 and 2, in the same periodical, 1938 and 1939) dealt with the Tortugas region and the western North Atlantic. Light and dark bottles filled with natural sea water and suspended near the surface were used to determine oxygen production and consumption, the utilization and regeneration of nutrients and the production and consumption of chlorophyll. Analyses were made of oxygen, chlorophyll and phosphates in the Long Island surface waters for a period of about a year. Counts were made of zooplankton and, during the last half of the investigation, nitrate determinations were made.

The quantity of chlorophyll in the phytoplankton was much higher than in the oceanic waters outside the sound. The nutrients, particularly phosphate, were also high; the ratio of nitrate to phosphate low. The amount of photosynthesis was influenced directly by the quantity of chlorophyll and by temperature and light. The similarities between experimental results and the events in the free water were considered sufficiently marked to permit the use of the former in making rough estimates of productivity.

In the latest paper an analysis was made of the methods of measuring phytoplankton, and it was found that the determination of plant pigments (after the method of Harvey, 1934) has the highest mean correlation with other types of measurement and is therefore the most nearly representative determination of phytoplankton. This portion of the work is a study of the quantitative aspects of the phytoplankton of Georges Bank in relation to the environmental factors which influence its growth and distribution. It is part of a general survey of Georges Bank by several investigators, the purpose of which is to obtain needed information about the spawning and larval development of the haddock.

APPOINTMENTS VACANT

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PLANNING REBUILDING AND DEVELOPMENT

THE interim report of the Uthwatt Committee on Compensation and Betterment has rightly been hailed as marking a definite stage in dealing with those problems of physical reconstruction in Great Britain which are now generally recognized as urgent. There is little dissent from Lord Reith's own view that they are urgent and pressing and that without diverting energies from the prosecution of the war, preparations must be made now to plan the rebuilding of Britain, and to consider the reconstruction of devastated areas, the location of industry, the preservation of the countryside and the conservation of natural resources. Only by planning now can we be ready to use the opportunities of rebuilding on better lines when the War comes to an end, and avoid mistakes made after 1918 which are now everywhere admitted.

The urgency of planning arises from two sources. The ground has to be prepared both with knowledge, without which future planning will not be equipped to serve any useful purpose, and with the machinery without which it will not operate at all. The first consideration involves research, the second legislation; and unless both are ready when the time comes, the opportunity will be missed, because the wrong forces may take control and plans are made hurriedly to meet partial difficulties without reference to wider or ultimate purposes. The real obstacles to planning have not been removed by bombing, and the main and urgent task is to see that they do not operate as before through lack of technical data, confusion of social and economic values, or the absence of legislative and administrative machinery.

Research for this purpose involves both technical and social study. As an admirable article in the June issue of the *Architectural Review* points out, architects do not know nearly enough about the new materials of their art, the new resources of modern science, or the needs their work has to meet. Minimum standards require translation into ideal standards based on profound scientific and social research. The sequence from this point of view is first the investigation of actual needs, then of available ways of meeting those needs and finally legislation to enable the resulting plans to be put into effect with efficient organization of the work.

On one point there is widespread agreement—the absolute necessity for an overriding authority. From the report of the Barlow Commission to that of the Uthwatt Committee itself, all the numerous bodies attacking the problems of reconstruction have assumed the establishment of a central planning authority, which would proceed to work out a national plan. The same point was strongly made by Lord Zetland at the recent annual meeting of the National Trust. The only

differences of opinion lie in the exact nature of the authority and the extent of its powers.

Much has already been done to prepare the ground. Following on the attention directed to problems of planning by the P E P report on the location of industry, and by the subsequent report of the Barlow Commission, many excellent articles and pamphlets have served to educate public opinion in the steps required. Among the more recent of such may be mentioned a further article on problems of reconstruction in the *Round Table* of June, the "Rebuilding Britain Series", the first of which. "Overture to Planning", by F. J. Osborn, has just been published*, and the admirable survey number (July) of the *Architectural Review*, devoted to the subject. Valuable features of the latter survey are the introductory account of the work of the Ministry of Reconstruction under Lord Addison during and after the War of 1914–18, and the account of the activities of a number of the bodies already at work in the field.

A number of these have already reported. The Architectural Science Group of the Royal Institute of British Architects has issued a report on the steps to be taken to foster a scientific approach on the part of the architect to his professional duties. The Council of the Garden Cities and Town Planning Association has submitted to the Cabinet a memorandum on "Town Planning in Relation to the Present Emergency and After-War Reconstruction". The Town Planning Institute has furnished two memoranda to the Uthwatt Committee, and has also prepared a report on compensation and betterment indicating the necessary developments of the general law of town and country planning. Memoranda already circulated by the Social Reconstruction Survey set up by Nuffield College include a "Note on the Shift of Population in the Great War", by M. P. Fogarty, a "Survey of Industrial Development in Great Britain Planned since the Commencement of the War", by P. W. S. Andrews, and a further memorandum by M. P. Fogarty on "Demobilisation and Transfer of Industry to a Peace Basis". Various relevant reports have also been issued by the Association of Architects, Surveyors and Technical Assistants.

A good example of the work which is being done in examining the problems of reconstruction in good time is provided by a report which has been published by the Oxford Preservation Trust giving the recommendations of its Committee on Planning and Reconstruction on some general aspects of the post-war problem. The future of the university city is still under consideration and will be the subject of an elaborate study already in preparation. In the present report the Committee, carrying on an inquiry initiated in peace-time, covers ground of interest to many areas all over the country, and discusses the problems involved in the future of Oxford as a great shopping, entertainment and distributing town and the administrative centre of public services over two counties and beyond.

The report indicates concisely some of the points upon which agreed conclusions by the planning authorities in Oxford and the surrounding district are essential; for example, the desirable ultimate population of a district within a radius of six miles of Carfax, having regard to essential public services, traffic relief or congestion in the central area, the conservation of urban amenities, agricultural land and a green girdle, and the provision of subsidiary community centres. Decisions as to the amount of industry desirable in the district, the maintenance of the balance of industry, the exclusion from the city of industries for which it was not planned and for which it is physically unsuitable, and the segregation of any industries in properly designed factory areas or small industrial estates are also imperative. The Committee also recognizes that, if a planning authority is to have freedom and initiative, the difficulties created by the multiplicity of private land ownerships and questions of compensation must be removed.

The Committee recommends the establishment of a regional planning board for an area comprising the City of Oxford, the County of Oxford, less the borough and rural district of Henley, and the part of Berkshire that lies north of the Berkshire Downs watershed. The board would plan the whole area, working to a single general plan and giving full consideration to the interests of agriculture and rural community life in general. The report stresses the importance of preventing ribbon building and makes concrete suggestions to remedy this situation as well as that arising out of private ownership of land and questions of compensation. It suggests a national planning fund to promote the creation of national parks as well as for the preservation of the coast line and its amenities; and it strongly emphasizes the need for a single Government department dealing with town and county planning, emphatically endorsing the unanimous conclusions of the Royal Commission on the Distribution of the Industrial Population regarding a central planning authority.

The establishment of such a central planning authority and the enactment of legislation dealing with compensation and land values are the points

* Overture to Planning. By F. J. Osborn. (Rebuilding Britain Series, No. 1.) Pp. 29. (London: Faber and Faber, Ltd., 1941.) 1s. net.

upon which opinion is clearly agreed as urgent. They are the keynote in the recommendations of the Uthwatt Committee itself, which assumes the establishment without delay of a central planning Authority which will proceed to work out a national plan. The Expert Committee then recommends that the Government should now announce, as a general principle, that compensation ultimately payable in respect of public acquisition of land or of the public control of land will not exceed sums based on the standard of "pre-war values", that is, values at March 31, 1939. This maximum should be adopted for the whole period required to determine the long-term policy of planning and to work out any alterations in the present principles governing compensation.

The Committee then recommends that the legislation to be introduced to establish the central planning authority should vest in that authority the power of controlling building and all other developments throughout Great Britain by reference to national planning considerations and with the view of preventing work being undertaken which might be prejudicial to reconstruction. Such power should come into operation forthwith and continue while the broad lines of reconstruction are being worked out. Areas which may possibly form the subject of a reconstruction scheme should be defined by the competent authority, and the areas prescribed, without waiting for the end of hostilities, so soon as a reasonable judgment can be formed upon the matter by the competent authority. The Committee further recommends that from the date when the controls recommended cease to be operative over all developed areas, no works of reconstruction or development within the specified "reconstruction areas" should be permitted, except with the licence of the central planning authority, for a further reasonable period after the end of hostilities while detailed schemes of reconstruction are being worked out and the areas to which they apply are finally determined.

The essence of the Uthwatt report is accordingly the note of urgency and the establishment of a central planning authority. The principle of the latter has already been accepted by the Government, as was announced by Lord Reith on February 26 and again in the House of Lords on July 27, when he said the Government had accepted the recommendation of the Uthwatt Committee that the cost of land required for rebuilding under a public planning scheme shall not exceed its pre-war value and also the principle that reconstruction areas should be planned as a whole and defined as early as possible. Financial gain by individuals out of landed property by reason of war conditions or post-war reconstruction is to be excluded, as well as a piecemeal patching up of damaged areas.

A central planning authority is required as an urgent emergency measure in order to secure the main purpose and to control rebuilding from that point of view as well as in regard to conservation of labour and materials. This step the Government has postponed in favour of a council of three Ministers consisting of the Secretary of State for Scotland, the Minister of Health, and the Minister of Works and Buildings as chairman. This Council is intended to function until a central planning authority is set up in its final form. This proposal has indeed been welcomed by Sir Montague Barlow as a definite step forward, on the grounds that a long-term planning policy will develop progressively, and that the Council is charged with the duty of ensuring that the administration of town-planning legislation and of legislation implementing the Uthwatt Committee's proposals shall march in step with such long-term planning policy. As the debate in the House of Lords showed, such confidence does not appear to be general. The apparent shelving of the primary recommendation of the Uthwatt Committee has led to widespread disappointment and criticism. It suggests that a forward planning policy is still very much in the clouds, and doubts may very legitimately be entertained as to whether the proposed Council of Ministers already heavily burdened with departmental duties will be able to rise above the level of an interdepartmental committee, the members of which primarily hold a watching brief on behalf of the rights and powers of their own departments.

In the event, of course, such fears may prove to be groundless. Lord Reith's own statement showed that the Government is alive to the importance of having planning systems and plans ready at the end of the War, and of the obvious consequences of being unprepared for peace. Those who are most anxious to see Lord Reith at the head of a central planning ministry with an adequate staff will only be too glad if the present step does avert definite evils before the War is ended and implement the surveying of the ground so that active reconstruction can proceed when the moment arrives. They should find some further reassurance in the attention to research which is already being given by Lord Reith. There has been nothing in his statements to warrant the belief that he will lose great opportunities by small thinking.

There are indeed other fields to which attention must be given. As the *Round Table* points out, there is general agreement that the structure of our system of local government is in many respects out of date. The old boundaries do not fit modern

conditions, and the areas are often too small for present-day services. The creation of a network of regional planning authorities is generally recognized as essential, and this step might in turn assist in dealing with the difficult boundary question as well as in the devolution of authority between central Government and local authorities. There is the further thorny question of the granting to planning authorities of very large powers of land purchase, sufficient to carry out the most comprehensive schemes. Again, positive rather than negative policy is required to eliminate ribbon development, while as the Oxford Preservation Trust emphasizes, agriculture, too, must be represented on the planning authorities and such interests fully safeguarded.

What matters most may well be the kind of stand made in the next few months by those who can speak with authority and experience on the subject of planning. Whatever their preoccupation with war-time tasks, those who have thought for years about the wider issues of town and country must guide the tremendous public interest which the Uthwatt report and Lord Reith's statement have further stimulated. Unless the fundamental issues are made plain and kept unconfused before the public, the old mistakes will be repeated and the future planning of Britain, which is already being shaped, will crystallize in forms defeating once more the high hopes now entertained.

That task of sane, clear thinking and patient, fearless, unprejudiced exposition is one which demands the co-operation of all men and women of good will who look for the building of a nobler and better Britain. They must supply the driving force to ensure that the strategy of planning which can start from the decisions already taken by the Government is made ready for immediate application. Their interest and support can well inspire the Uthwatt Committee as it proceeds with its investigations, and stimulate the rapid framing and placing before Parliament of the legislation already required. They can assist to bring local authorities together in conferences and encourage them to prepare for the duties and developments which the future holds for them.

Scientific workers have their own special part to play. For some there may be participation in the technical side of planning, in the scientific and sound research which must form its basis. For others there may well be response to the appeal in the *Round Table* for a larger number of men and women of character, energy and ability to accept the burdens of the indispensable form of public service represented by the local authorities; and there can be few who could not make some use of such an exposition of the subject as is given in the *Architectural Review*, with its analysis of the main questions and issues, to take part in the task of educating themselves and their fellow-citizens as to the decisions to be taken, the problems to be solved and the efforts demanded of all if Britain is to be replanned and rebuilt on lines worthy of the sacrifices now being made.

SCIENCE IN THE SIXTEENTH CENTURY

A History of Magic and Experimental Science
Vols. 5 and 6: The Sixteenth Century. By Prof. Lynn Thorndike. (History of Science Society Publications, New Series 4.) Vol. 5. Pp. xxii+695. Vol. 6. Pp. xviii+766. (New York: Columbia University Press; London: Oxford University Press, 1941.) 66*s*. 6*d*. net.

THE sixteenth century is commonly regarded as marking the birth of modern science. It owes this distinction mainly to the achievements of a small number of men, of whom Copernicus, Vesalius, Gilbert, Tycho Brahe, Gesner, Libavius, Bruno, Fracastoro and Porta are the most famous. These constituted a very small percentage of the authors who enjoyed some sort of reputation among their contemporaries for their views on natural phenomena. Prof. Thorndike deals with about 1,200 such writers. The vast majority of them were of little, if any, scientific importance.

As a whole, the sixteenth century was more medieval than modern, and showed great credulity rather than an appreciation of the spirit and method of science. Of originality it showed extremely little. Most of its more sensible ideas, and nearly all its superstitions, were derived from earlier times. Although there was some diversity in the sort of superstitions which the various authors adopted from their predecessors, the diversity was neither great nor important. The practice of magic rites declined, but the belief in magic, astrology and all kinds of 'mancies' (aeromancy, geomancy, hydromancy, necromancy, etc.) continued to go strong. Even sceptics or atheists like Sanchez and Vanini could not escape the coils of superstition; and the few pioneers to whom the age owed its place in the history of scientific progress shared to an amazing extent in the credulity of their contemporaries,

though fortunately they managed to keep their best work sufficiently free from unscientific encumbrances. The intellectual atmosphere of the environment influences even great men. It would ill become us to be severe on them, considering the alarming extent to which astrology, alchemy, etc., still continue to engage the interests of the twentieth century, the intellectual and moral instability of which recent events have exposed only too glaringly.

Some readers may wonder whether it was worth while devoting two big volumes to a horde of writers, most of whom were little more than parrots, or plagiarists, or charlatans. But a scholar has a right to determine his own field of research. Prof. Thorndike is obviously interested in the sixteenth century as such, and he has succeeded in portraying its mentality with the aid of the large sample he has surveyed. The picture is not exhilarating, but it is true to life. The average historian of science is not concerned with any period as such, only with the *progress* of science in it, so he ignores the authors who have not contributed to that progress. This likewise is a justifiable attitude. There is no reason for quarrelling over this difference in attitude, as Prof. Thorndike occasionally seems inclined to do. The sensible historian will not retort by deprecating Prof. Thorndike's 'antiquarianism', but will know what use to make of it. The very possibility of writing history, as, indeed, of most studies, depends on selection; and selection always involves the risk of important omissions. By examining, and reporting on, such masses of frequently neglected material, scholars like Prof. Thorndike render a real service to the historian of science. At best, the result may be additional information, or correction; at worst, the historian will at least have the feeling that he may ignore so much with a good conscience.

Prof. Thorndike's volumes have "experimental science" as part of their title. The expression usually means "the systematic study of natural phenomena under conditions controlled by the investigator". The author, however, must be using it in the older sense of "any kind of alleged knowledge professing to be based on experience". For the amount of experimentation dealt with in these volumes is quite negligible. The experiments reported are extremely few and simple, and even the merely observational verifications referred to are mostly of a poor scientific standard. The best experiment cited is that by which Carpi showed, by injecting water with a syringe, that there is no sieve in the kidneys. The most amusing one is that by which Henry VII refuted a certain astrologer who had predicted the king's death before Christmas. He summoned the astrologer and asked him where, according to his astrological knowledge, he expected to spend Christmas. The astrologer replied that he would be at home. Thereupon the king had him imprisoned in the Tower of London until after Christmas. It is regrettable to find that Queen Elizabeth did not profit from this royal refutation of astrology, but was rather addicted to it, and taken in by charlatans.

Prof. Thorndike does not give a full account of the scientific work of the major pioneers, nor does he add much to our information about them. But he does sometimes throw a little new sidelight on them, or suggests new ways of regarding them. As an example of this, some of his comments in connexion with Copernicus may be indicated briefly. Ideas of a moving earth were spreading already, before and independently of Copernicus, so that even some of his ecclesiastical contemporaries were prepared for the appearance of his "De revolutionibus", and so far from opposing its publication, actually tried to hasten it. Partly, it is true, this interest was prompted by the hope of a new astrology to be based on the new astronomy; but that is a detail. The main obstacle to the early spread of Copernicanism was not religious opposition, but the lack of a suitable text-book for beginners. The writers of the many introductory books on the rudiments of astronomy found it much easier to follow the conventional methods of presenting Ptolemaic astronomy than to follow the intricate novelties of Copernicus. The result was that few really understood the new astronomy; and people generally tend to condemn what they fail to understand. If Galileo had used his great gifts to write a graphic elementary account of Copernican astronomy, instead of writing his provocative "Dialogue concerning the Two Chief Systems of the World, the Ptolemaic and the Copernican", things might have been very different.

Prof. Thorndike's work contains also a considerable amount of bibliographical and kindred information. It is noteworthy that of the authors discussed the British are fewer than the Spanish. Of the three hundred printers and publishers referred to only nine were in London, whereas Venice could boast about fifty, and Paris about thirty-five. Apparently through some oversight, the list of printers in Appendix 6 does not include the famous Elzevir.

No one can fail to appreciate the labour, patience and learning that have gone to the writing of these volumes, which, together with four earlier ones, complete a remarkable survey of sixteen centuries of thought about natural phenomena. Prof. Thorndike richly deserves the warm congratulations and gratitude of all who are interested in the history of human thought.

A. Wolf.

GROWTH OF SCIENCE IN CANADA

History of Science in Canada
By Frank Dawson Adams, W. Lash Miller, Frère Marie-Victorin, J. R. Dymond, Leo E. Pariseau, J. J. Heagerty, W. E. Harper, Samuel Beatty, A. Norman Shaw. Edited by H. M. Tory. Pp. vi+152. (Toronto: The Ryerson Press, 1939.) 2.50 dollars.

It is likely that in most of the new countries of the world science takes dominant place alike in the educational field and in popular esteem. Circumstances combine to promote the development of scientific knowledge of one kind or another. Not only does the development of new resources give a direct economic stimulus to science but also there is probably a deeper influence at work and that is the stirring phenomenon of growth of a young country. New cities springing up, oil discovered here, minerals there, new industries born, railroads built, forests cut—these things make their mark upon the minds of the people so that they have an urge towards fresh knowledge. It is not the study of the old, not classics, nor even literature or history, but science which has the widest popular appeal and to which young students turn in ever-increasing numbers. Factors such as these lie behind the long story of the remarkable development of science in Canada which is told here.

The book consists of nine papers presented to the American Association for the Advancement of Science in 1938 to direct the attention of the Association to the growth of science in the Dominion. These papers, written by leading Canadian men of science, are edited and introduced by H. M. Tory, past-president of the Canadian National Research Council. He stresses the rapidity with which science progressed in the past sixty years in both Government departments and teaching and research institutions. The foundations of Canadian science were of necessity laid by men from overseas (whether as pioneers or trained scientists) but in course of time Canadian-trained scientists took their part in both research and teaching, until to-day Canada supplies a fair quota of scientific work and leadership.

Chapter i, by F. D. Adams, is devoted to the history of geology in Canada, from the 1820's onwards. The first work was done by officers of the British army and navy stationed in Canada. Amongst these was John Bigsby (the founder of the Bigsby Medal) who prepared one of the very earliest geological maps of North America. The next stage was the appointment of W. S. Logan as Government geologist in 1842. There was then no staff, equipment, laboratory or library. Undaunted, Logan acquired a few assistants and started the Geological Survey of Canada on its course. Among the earliest work undertaken were studies of the pre-Cambrian rocks of the Canadian Shield, work which was—and is—among the foremost contributions to geological knowledge. Economic developments within the Dominion are reflected in the economic aspects of the publications of the Geological Survey. The winning of ores, the opening of coal- and oil-fields, all are events in which it has played a leading part. The work of geologists in the universities is also outlined. Naturally, the demand for trained geologists has greatly stimulated the teaching of this subject.

Lash Miller writes amusingly about the early days of chemistry in the universities and also touches upon some of the major developments in chemical industry. A brief chapter on Canada's contribution to the science of botany, by Frère Marie-Victorin, is somewhat disappointing. The botanists may well feel that their work has not been adequately described and much more might have been said about agriculture's debt to botanical research. J. R. Dymond gives succinct account of the growth and recent developments in zoology and stresses the happy relations which exist to-day between university and Government laboratories. University biologists derive great benefit from opportunity to work in biological stations during the summer months.

The piecemeal effect, although unavoidable in a book of this kind, is a defect in connexion with the natural sciences, for their development really should be one connected story. It was the observations of pioneers and explorers which laid the foundation on which were built the detailed studies of the present day. It is a long story which starts in a note-book about unexplored country and ends in the modern laboratories of a great Dominion.

The history of medicine is treated in two chapters—Canadian medicine and biology under the French regime, by L. E. Pariseau, and medical practice under the British regime, described by J. J. Heagerty. Events of those early days make interesting reading, but little is said of recent medical work or the development of the medical schools.

The last three chapters cover astronomy, mathematics and physics respectively. W. E. Harper's clear account of astronomical work is interesting. Canada has reason to be proud of the enterprise which has given her the two great telescopes, one at Victoria and one on the outskirts of Toronto. Important and original work has been done at the observatories. The chapter on mathematics is

somewhat weak. The author writes rather as one defending the subject than as an historian of its progress, and too much emphasis is given to minor work. In the concluding chapter, on the advance of physics in Canada, A. N. Shaw gives a good general survey, outlining the present work in physics and the date of establishing laboratories, etc., at each of the Canadian universities. He points out the influence of the Cavendish Laboratory at which so many of the Canadian physicists have been trained. The history of physics in Canada is, of course, bound up with that of the late Lord Rutherford who in his ten years at McGill gave such a profound impulse to physics in the Dominion. The writer says: "Undoubtedly Lord Rutherford may claim sole responsibility for the greatest outburst of original research in Canada and the subsequent influence of his personality and works is beyond assessment."

T. ALTY.

UNIVERSAL ALGEBRA

The Calculus of Extension

By Prof. Henry George Forder, including Examples by Robert William Genese. Pp. xvi+490. (Cambridge: At the University Press, 1941.) 30s. net.

ABOUT a hundred years ago, when Boole and Hamilton were extending algebra by symbolizing logical and physical entities, a similar but independent investigation was begun in Germany by Grassmann. Unlike the quaternions of Hamilton, which aroused considerable interest and became very well known, the calculus of extensive magnitudes of Grassmann attracted very little attention until the close of the nineteenth century. The appearance of Whitehead's "Universal Algebra" first made this theory well known to English readers, and the book still remains a classic, by providing an interesting and readable approach to the philosophy both of Boolean and Grassmannian algebra. The aim of the work now under review is to give a more detailed account of Grassmann's methods, and particularly to exhibit their power in all forms of geometry, metrical, kinematical and projective. The book is the outcome of many years experience and appreciation of the methods: it was begun twelve years ago as a result of perusing some mathematical notes on Grassmann left by the late Prof. Genese, and its publication has tarried through no fault of the author. The book, which goes far beyond the scope of the original notes, is full of information, and shows very clearly the power of the method and its surprisingly wide range of applications.

The calculus of extension is a form of non-commutative algebra which includes and absorbs ordinary vector theory. It can be developed in the abstract, and then applied, by means of its wealth of identities, to concrete problems in the theory of determinants, in nearly all forms of geometry, and in physics. In this respect it resembles analytical geometry, where the same algebraic form may represent at one time the locus of a point, and at another time the envelope of a line, according to the interpretation of the variables. This capacity for varied geometrical usage is, however, considerably greater in Grassmann's algebra than in co-ordinate geometry. It differs from the latter in discarding as unnecessary a co-ordinate frame of reference; and in this respect it returns to the earliest traditions of geometry.

The chapters run as follows: (i) Plane geometry, preceded by a page of bare axiomatic statements on extensive magnitudes, immediately interpreted as points and vectors. This leads to the use of similarity operators which provide neat proofs of remarkable theorems such as the Cayley Clifford problem of three-bar motion; (ii) Geometry of three dimensions, including spherical trigonometry; (iii) More axiomatic statements leading to projective geometry, where the richness of the method begins to be manifest: (iv) The theory of screws and the linear complex; (v) Differentiation and motion; (vi) Projective transformations. In Chapters vii–xv we have the general theory for any number of dimensions, including a discussion on matrices, and applications to quadrics in general, to circles, spheres and spherical 'spreads'. The final chapter, which bears on canonical forms, deals with the theory of algebraic products, recently developed by Müller, one of the chief exponents of Grassmann on the Continent.

The book is written most carefully and consistently; and it is evident that the author appreciates the value of a simple notation as an aid to thought. But it is doubtful whether the unfamiliar capital Gothic type for matrices is a happy choice in a work which seeks to persuade the reader to adopt a new outlook and new methods. The author endorses the motto adopted from Leibniz by Grassmann: *etsi omnis methodus licita est, tamen non omnis expedit.* It is surprising that a method of algebraic geometry can be pursued through so long a book without the mention of invariants and with the briefest allusion to the theory of groups. Nevertheless algebraists and geometers will find the book stimulating.

H. W. TURNBULL.

Textbook of Light.
By Dr. R. Wallace Stewart and Prof. John Satterly. Seventh edition, revised by Prof. C. T. Archer. Pp. vii+365. (London: University Tutorial Press, Ltd., 1941.) 7s. 6d.

IT is not an easy task to set about revising a well-known book, since the characteristic features must be preserved, and yet the contents must be brought into line with modern development. This task has, however, been successfully accomplished by Prof. Archer in the revised version of Stewart and Satterly's "Textbook of Light". The book contains a treatment of the elements of geometrical optics of a fairly wide scope, and the mathematics is easily within the compass of Intermediate Science students for whom the book is intended; the methods of the calculus, however, might surely have been used, especially in certain cases.

In connexion with a book of such merit as this, one hesitates to offer any criticism, however slight, but two topics may be mentioned. Thus the use of pins for experimental work on mirrors and lenses is still retained, although it is probably much more convincing for students to use narrow parallel pencils of light; such procedure also saves time in experimental work. Again, so painstaking is the author to drive home facts that there is a tendency for over-emphasis; for example, having established the relationship $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ for mirrors, why trouble to express this result in words?

The book has been brought up to date (though one misses any reference to photo-electric methods in photometry), and it can certainly be recommended.

The Practical Application of Aluminium Bronze
By C. H. Meigh. Pp. xiii+112. (London and New York: McGraw-Hill Publishing Co., Ltd., 1941.) 17s. 6d.

THE alloys of copper with aluminium, with or without the addition of manganese, iron, or nickel, are commonly known as aluminium bronze. They have a high tensile strength and other good mechanical properties, and are highly resistant to corrosion. The handsome French franc and 2-franc pieces of this alloy, which had the appearance of gold and retained their colour permanently, will be remembered. Trouble owing to the entanglement of particles of alumina long retarded the general use of the alloys, but these difficulties have been overcome, and the advantages of the material can be fully utilized.

This book contains a number of practical notes on the composition and properties of the group of alloys, and detailed accounts of foundry and workshop practice, which will be found useful by all who have to make or work aluminium bronze. It is weaker on the scientific side, the accounts of crystal structure and of such phenomena as fatigue being marred by numerous errors. The tables at the end of the book include comparisons with steel and with brass and bronze, but the important high-tensile brasses are not included, although the comparison with them would have been fairer.

The term "de-aluminification" is not to be welcomed as an addition to the language, and is unnecessary.

There are some good illustrations of castings in aluminium bronze. C. H. D.

Higher Chemical Calculations
By A. J. Mee. Pp. viii+184. (London: J. M. Dent and Sons, Ltd., 1940.) 5s.

THIS book provides about 600 numerical problems on the principles of physical chemistry (including analyses) up to the standard of the Intermediate B.Sc. examination. Some of the examples are taken from the Higher Certificate, First M.B., Intermediate B.Sc. and University Open Scholarship examinations, but the majority are either original or taken from the researches which have laid the foundations of physical chemistry. The answers to these problems are given at the end of the book, together with logarithm tables and a useful index.

The subject-matter is well arranged. Thus the principles underlying the calculations are classified into ten main groups each of which forms the basis of a complete chapter. Clear and concise details of the principles are provided, and these are illustrated by worked-out examples so that the student can become familiar with the application of the principle before attempting the problems. The worked-out examples are generally satisfactory, but it is unfortunate that the answers to some of them are given to a greater number of significant figures than the measurements. Obsolete and misleading problems on the degree of dissociation and ionization of strong electrolytes are also worked out or given for solution; for example, sodium nitrate is calculated to be "63·3 per cent ionised" from the freezing point of its aqueous solution (p. 122). Apart from these criticisms, the book can be recommended for the use of sixth-form pupils and first-year university students.

A. C. C.

British Water Beetles
By Frank Balfour-Browne. Vol. 1. (Ray Society Vol. 127 for 1939.) Pp. xx+376+5 plates. (London: Bernard Quaritch, Ltd., 1940.) 25s.

AQUATIC Coleoptera have long been favourite objects of study, especially by the biologist and the physiologist. Dytiscus, Gyrinus and Hydrophilus, for example, have alone attracted the attention of many investigators and a bibliography of their written contributions on these creatures would fill many printed pages. The present volume deals with members of the Haliplidæ, Hygrobiidæ and part of the Dytiscidæ. It is concerned more especially with the habits and distribution of their species and is not intended as a systematic treatise. It will be noted that keys, therefore, take the place of detailed descriptions as aids to the identification of the various species. Prof. Balfour-Browne has devoted many years to the study of water beetles and is probably better qualified than anyone else in England to describe their natural history and where to find them. Coleopterists will welcome the appearance of this well-produced volume and look forward to the completion of the work when circumstances permit.

CHANGES IN THE GOVERNMENT OF INDIA

By Sir Denys Bray, K.C.S.I., K.C.I.E., C.B.E.
Formerly, Foreign Secretary, Government of India

On July 22 the Viceroy of India made an announcement that came as a great relief to many in Great Britain who had been chafing under our apparent inability to do anything to relieve the political deadlock in India. It was a notable announcement; yet its wording was studiously matter-of-fact. It merely stated that as a result of the increased pressure of work in connexion with the War it had been decided to enlarge the Executive Council of the Governor-General of India, and to establish a National Defence Council in order to associate Indian non-official opinion so far as possible with the prosecution of the war; and then followed the names of seven Indians who were to join the former and of twenty Indians who (with two non-Indians) were to represent British India on the latter.

To those in Great Britain with no knowledge of the working of the Government of India, the Viceroy's announcement can have conveyed little of its true significance. When Mr. Amery in a weighty speech expounded these changes in the House of Commons, his statement was received with calm satisfaction, tempered only by expressions of regret that they did not go further. The House seemed scarcely conscious that anything out of the way had been enacted; indeed the Secretary of State was at pains to emphasize that the changes involved no alteration in the constitution but were merely administrative changes, interim measures taken within the existing framework. Yet it may be doubted whether these changes will not figure in history as in some ways an even more significant milestone on India's road to full nationhood than the great constitutional change embodied in the Government of India Act of 1935 after months of heated debate. For that Act, while it brought self-government to the eleven Provinces of British India, left the Central Government for the time being untouched. But the changes now so modestly introduced affect the working of the Central Government itself.

For the Viceroy's Council is no mere advisory body. In the Governor-General in Council, to use the technical term, is vested the supreme authority in India. The Council is in fact a Cabinet with collective work and responsibility, composed of Ministers—or Members as they are called—each in control of one of the great Government departments, the Viceroy himself being member for foreign affairs. During the first fifty years of its being the Council was purely British in composition. Not until 1909 was an Indian appointed; not until 1920 was the number of Indians raised to three; and now the Viceroy is to preside over a Cabinet with Indians in a majority of two to one. It is a transformation that would have made Lord Curzon stare and gasp. That it evoked not a word of dissent in Parliament (except on the score that it did not go far enough) and scarcely a word of criticism in the Press is significant of the wholesale and very wholesome change that in half a dozen years has come over political thought in Great Britain. It is to be hoped that a very full report of the debate and the subsequent Press comments was telegraphed to India. The warm-hearted spirit in which the changes have been welcomed in Great Britain is likely to prove more acceptable to political India than the changes themselves.

No one with any knowledge of the political currents in India to-day could be so sanguine as to expect a general welcome from India for any changes which do not involve a formal change in the constitution. We in Great Britain pride ourselves on the vitality and unseen growth of our own unwritten constitution, and are inclined to eye written constitutions not a little impatiently—if indeed we can bring ourselves to study them at all—and to judge them not by the written letter but solely by the spirit in which they are worked. Naturally enough, it is otherwise with Indians. Accustomed as they are to a written constitution, they look jealously at every letter in it, and are apt to assume that the checks and safeguards every written constitution must perforce contain are a faithful reflex of its everyday working. Though the present changes, as Mr. Amery told the House, are a signal "earnest of our desire to transfer to Indian hands a steadily increasing share in the control of India's destiny", they are interim adjustments only, pending the day when Indians are able to accept our invitation "by agreement among themselves to devise the framework of the Indian constitution in accordance with the social, economic and political structure of Indian life". The changes mark an abiding and far-reaching change in the spirit of the constitution; and it is history's lesson that in the life of a nation it is the spirit that quickens. But great though the change in the spirit, the letter of the constitution remains unchanged. The Governor-

General in Council, though the supreme authority in India, is still responsible to the Secretary of State for India and ultimately to Parliament. However responsive the Council may be to the Indian Assembly—and with Indians in an overwhelming majority it is a foregone conclusion that its responsiveness will be very sensibly quickened—its members are not responsible to it; nor can the Assembly turn them out of office. Hence, with the constitution left unaltered, the All India Congress declined to have anything to do with these interim measures or to allow its adherents to join the Council. The Muslim League, though glad enough that the constitution has been left for the time being as it is, laid down conditions for its own participation too exacting for acceptance.

It is, of course, a misfortune for India and for the British Commonwealth that neither of the two leading parties is formally represented on the Executive Council. Yet the Council will contain men who, abating nothing of their robust nationalist patriotism, have only dissociated themselves from their party over the non-constructive tactics it is pursuing. Happily, India has no dearth of public men of ability; and among the new members—of whom three are Hindus, bringing the number of Hindus on the Council to four, three are Muslims and one a Parsee—are men who have made their mark in India, and are not unknown in Great Britain and in the United States and at Geneva. Together they form a strong reinforcement to the Council.

How well off India is for public men may be seen from the names in the long list of appointments to the National Defence Council. This is an entirely new body. Unlike the Viceroy's Council it is not an executive but an advisory body, designed to bring the war effort in the Provinces and States into more direct and effective touch with the Central Government. Except for one representative of European commerce and another of the resident Anglo-Indian community, it is purely Indian in composition. It includes the Prime Ministers of four of the Provinces, representatives of labour, capital and agriculture, and well-tried champions of the depressed classes. Perhaps its most striking feature is the inclusion of a gifted Muslim lady—a wise appointment justified by a fine record of public service, and a fitting recognition of the swift and splendid awakening of India's womanhood.

These representatives of British India are to be joined on the Defence Council by representatives of the Indian States—that vast Indian India which, though an integral part of India, is not British India at all but under the rule of hereditary chiefs and princes. Who can doubt that India's war effort, already far greater than any one could have prophesied two years ago, will rapidly increase in vigour and magnitude, now that some of the best minds in the Provinces and the Indian States are to combine in a joint endeavour to stimulate it?

But the strengthening of the Central Government and the intensification of India's war effort are not all that may be looked for from this influx of Indians into the Viceroy's Council and this gathering of Indians from Provinces and States in a National Defence Council. It is not too sanguine to hope that these innovations will help to prepare the ground for the even more difficult task of constitution-building that lies ahead of India. To-day what stands in the way of India's self-government and evolution to her full status is, as Mr. Amery put it, "the absence of any willingness among Indians themselves to agree upon the lines on which they will govern themselves". Hitherto the rock of stumbling has been India's intolerance of her own diversity. But we in Britain have learnt that there is nothing like joint work for a supreme cause in a supreme crisis to bring about understanding of our political opponents, tolerance of their views, and a silent revolution in our own; and Executive Council and Defence Council alike will afford such joint work in plenty.

The characteristics of English-speaking peoples—and political India, be it remembered, is an English-speaking people—were summed up in memorable words by a statesman speaking in London a few weeks ago. "English-speaking countries are peopled by men and women of diverse nationalities and different religions. Their strength comes from diversity, and their freedom is born of tolerance—tolerance of other people's origins, other people's religions, other people's ideas. It is the crowning virtue of English-speaking countries that they recognize and respect virtue wherever they find it, and are not inclined to beguile themselves with a primitive and barbaric idea that they themselves have a monopoly of it."

These are the words of one whom many Indians in the ranks both of labour and capital know well. They are not the words of an Englishman. They are the words of the late head of the International Labour Office, now the American Ambassador in London. No words could better sum up the spirit in which all lovers of India long to see political India set itself to the task of working out India's salvation. The future of India, that great cosmos of nations, cannot lie in any one race or religion or party claiming for itself the monopoly of political wisdom and authority. India's salvation can only lie in the Indian's tolerance of other Indians' origins, religions, ideas. In India's rich diversity, in India's triumphant unity in diversity lies—who can doubt it?—her future strength.

THE PRICKLY-PEAR PROBLEM IN AUSTRALIA

By Dr. A. D. Imms, F.R.S.

THE entry of the prickly-pear into Australia dates from about 1787, when the species *Opuntia monacantha* was introduced from Rio de Janeiro. The object was to establish the cochineal industry in that land since prickly-pears constitute the host for this particular kind of insect. Some twenty-five other species of Opuntia have found their way into Australia, but their origins cannot be traced. All have become naturalized either as serious pests, minor pests or as garden escapes. The two major pest species in Australia are *Opuntia inermis* and *O. stricta*. At one time landowners grew hedges of prickly-pear around their homesteads until they got out of hand and then the hedges were cut down. The rapidity with which these pests have increased is one of the botanical wonders of the world. Their original home is the coastal sector of Texas and Florida where the mean rainfall is 40–50 in. Yet in Australia the plants have adapted themselves to a very different environment and with a precipitation of only 20–30 in. annually. In 1900 an area of about 10,000,000 acres was affected in Queensland and New South Wales. The invasion advanced with such celerity that at the peak, in 1925, the affected area must have been greater than 60,000,000 acres : in some years the annual increase in infested territory exceeded 2,500,000 acres. The main distribution takes place by seeds, but every broken-off segment of the plant is liable to take root.

The problem of the control and eradication of the pest has been a matter of cost. The great bulk of the infested territory, stretching 900 miles between lat. 20° S. at Mackay, Queensland, to lat. 33° S. at Newcastle, N.S.W., is natural grazing land generally worth less than £1 per acre. Biological control of prickly-pear was first advocated in Australia in 1899. In 1912 the Queensland Government appointed a Travelling Commission to investigate possibilities of biological control in view of the increasing difficulties facing mechanical and chemical methods of eradication. The Commission comprised Dr. T. Harvey Johnston, professor of biology at the University of Queensland, and Mr. Henry Tryon, Government Entomologist to the State. They visited many countries where prickly-pears were indigenous or had become acclimatized and made valuable recommendations for the introduction of insects and diseases affecting Cactaceæ. During these travels small stocks of the cochineals, *Dactylopius ceylonicus* and *D. greenii*, were forwarded to Australia. The first-named was liberated in the field and in a few years it almost completely eradicated *Opuntia monacantha* and this achievement gave a stimulus to efforts in biological control.

In 1920 the Commonwealth Prickly Pear Board came into being with Prof. T. Harvey Johnston as scientific controller. It was established to investigate the whole question of the biological control of prickly-pear, being supported by the Commonwealth Advisory Council of Science and Industry and by the Governments of Queensland and New South Wales. Mr. Alan P. Dodd's report* is an official record of the campaign and its progress from the Board's inception in 1920 up to the year 1940. The Board, it may be added, has been an independent body from its start, exercising complete control over its investigations, finances and staff. During the nineteen-year period June 1920 to May 1939 the sums actually spent on prickly-pear control amounted approximately to £168,600.

The operations of the Board were governed by the fact that in America insects, diseases and other agencies keep the prickly-pear within reasonable bounds, whereas in Australia such natural controlling agencies are wanting and there is little check on the spread and reproduction of the pest. The Prickly Pear Board was concerned with an attempt to bring about a condition of biological equilibrium by the introduction of insects and diseases likely to provide natural checks. The control aimed at depended upon the introduction of a complex of organisms working collectively in destructive unison. Officers of the Board studied insects affecting Opuntia in many lands, covering widespread areas of cactus growth in North America, South America and the West Indies. In work of this character it is important to study on the spot, not only those insects actually attacking prickly-pear, but also the natural parasites and predators affecting them. The exclusion of such restraining agents from Australia, if their hosts are to multiply freely and vigorously attack the prickly-pear in the new surroundings, is of prime importance.

The Board established a station at Uvalde, Texas, where extensive preliminary biological work has been carried out and the most promising cactus-feeding insects bred under caged conditions. Also, such insects were tested by starvation and other means regarding the possibilities of their attacking cultivated plants of economic value. The selected

* The Biological Campaign against Prickly-Pear. By Alan P. Dodd. Published under the authority of the Commonwealth Prickly Pear Board. Pp. iv+177+37 plates. (Brisbane: Government Printer, 1940.)

Fig. 1.
DENSE PRICKLY-PEAR, *Opuntia inermis*, PRIOR TO ATTACK BY INSECTS, CHINCHILLA, QUEENSLAND, OCTOBER 1926.

species received from America were shipped to quarantine buildings at Sherwood, near Brisbane. Here they were again bred through one or more generations in order to preclude the escape of any parasites that might have been accidentally introduced at the same time. Also, additional tests were undertaken in order further to explore any possibility that the introduced insects might attack crops or other useful plants and not confine their activities to prickly-pear. From Sherwood, species that were deemed promising and that had withstood the foregoing testing, were eventually forwarded to acclimatizing and breeding centres where the first liberations into the open country were usually carried out.

In all, twelve species of prickly-pear insects were introduced and established in Australia. On the other hand, 150 species of cactus-feeding insects were discovered in America and of these about 50 species were imported into Australia. It will be noted that the greater number were rejected for various reasons. Many were confined to cacti other than Opuntia ; others caused too little damage to be of potential value, while some forms were discarded because they did not pass the stringent tests as regards their feeding propensities. Lastly, the unexpected and overwhelming success attending the introduction of a single species of insect rendered further importations of other kinds superfluous.

Of the various species that have become acclimatized to Australian conditions the moth *Cactoblastis cactorum*, the larvæ of which tunnel through the tissues, is the most important. The cochineal became distributed almost everywhere in the prickly-pear country and the plant-sucking bug, *Chelinidea tubulata*, spread in countless millions over various localities. The red spider, *Tetranychus opuntiæ*, said to be only a biological race of the European *T. telarius*, also spread over many thousands of square miles. In his 1929 report Dodd stated that the established complex of insect enemies was already bringing about a considerable degree of prickly-pear control. In the heart of the infested country it was possible to travel for 100 miles without seeing any healthy plants. Thus it would appear that the original conception of a biological association of different enemies working in unison was well justified. It was quite unforeseen, and could not have been foreseen, that the outstanding success in the repression of prickly-pear achieved up to 1936 would have resulted from the activities of a single species of insect. The agent in question is the Phycitid moth, *Cactoblastis cactorum*, from South America. This fact is all the more remarkable because only one small consignment of material was introduced into Australia. It took the form of about 2,750 eggs obtained in the Argentine in March 1935 and, a year later, two generations of this insect had been reared in captivity, the original number multiplying to 2,540,000. Between 1928 and 1930 about three thousand million eggs, laid by the descendants of insects from the original batch, were distributed in the prickly-pear areas. The

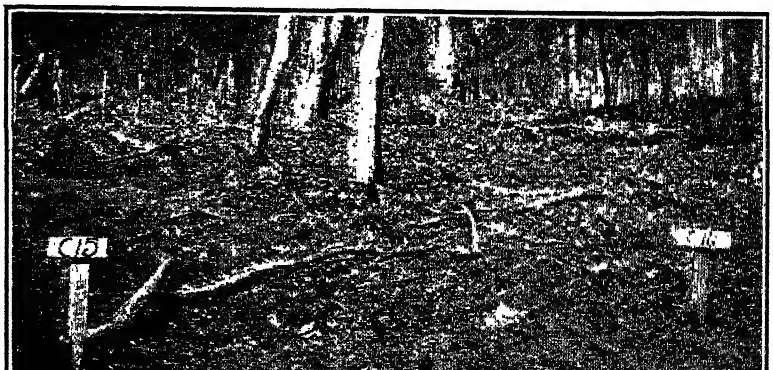


Fig. 2.
THE SAME AREA AS IN FIG. 1 THREE YEARS LATER, OCTOBER 1929, AS A RESULT OF THE ONSLAUGHT OF CACTOBLASTIS.

orange-red larvæ are gregarious internal feeders, which tunnel in companies through the tissues of the plant, thus providing also for the ingress of disease organisms. In this manner the prickly-pear ultimately becomes so completely destroyed that it is reduced to a rotting mass of pulp.

The various other insects that were established have either become suppressed, or their activities nullified, owing to competition with the Cactoblastis. It is only locally, and in relation to a few Opuntia species of minor importance, that the Cactoblastis has shown itself to be ineffective. The most serious of these plants is *Opuntia aurantiaca*, but there is good reason to believe that its control by a species of Dactylopius (cochineal), also from the Argentine, seems assured.

The results of the repression programme have led to 22,000,000 acres of former dense pear country in Queensland being selected for settlement. The previous value of this land was almost nothing, but freed from the pest its capital value would average 10*s*. an acre, without taking into consideration the worth of the new improvements in fencing, water facilities, removal of timber, etc. Hence the State has gained an asset of at least £10,000,000 because of the availability for farming of land hitherto useless. The area once under impenetrable prickly-pears, and now converted to dairy pastures, must exceed 1,000,000 acres on which many hundreds of new settlers live. In New South Wales the greater part of the former prickly-pear country has been brought into production, mainly for sheep grazing, and most of it has been utilized to enlarge adjacent pastoral properties.

The present status of Cactoblastis is satisfactory. Concentrated numbers of larvæ are still attacking, reducing and destroying many of the remaining prickly-pear areas of heavier growth. Native parasitic Hymenoptera are not exercising an undue amount of control and their importance is not growing. After an interesting discussion of the future of the problem, Mr. Dodd concludes that, up to date, there is no indication that prickly-pear will not continue to be held in complete subjugation by its remarkably efficient lepidopterous enemy.

THUNDERSTORM PROBLEMS

By Dr. F. J. W. Whipple

On July 20 the London Branch of the Institute of Physics visited the Royal Meteorological Society at South Kensington to take part in a discussion on "Thunderstorm Problems". Sir George Simpson, president of the Royal Meteorological Society, was in the chair—a happy arrangement, for Sir George has been working at thunderstorms for nearly forty years; his classical work in India, which included the experiments on which the breaking-drop theory of the production of electricity is based, was published so long ago as 1909 and his most recent papers on the subject describe work of equal importance.

The discussion was opened by Dr. T. E. Allibone, who spoke on "The Physics of Lightning". His survey began with the year 1889, when Vernon Boys told the Physical Society that a lightning flash consisted of many separate strokes traversing the same path. Later, Hoffert recorded eight strokes on a photographic plate by waggling the camera about a vertical axis, and Walter, by using a camera mounted on a turn-table, was able to show that the strokes might be spread over a period of a second. It was Boys again who constructed a camera incorporating two identical lenses rotating about a common axis. The two images of a flash photographed with this camera were distorted differently and, the rate of rotation of the lenses being known, the speed with which the flash had developed could be determined. The Boys camera has been used effectively by Schonland in his studies of storms in the neighbourhood of Johannesburg.

Schonland and his collaborators demonstrated that a lightning flash to earth is a very complicated phenomenon. There is a preliminary 'leader' which starts from the cloud and sends out a number of branches; when one of these reaches the ground it becomes the channel for the main stroke up which the luminosity travels from ground to cloud. Subsequent leaders and main strokes use the same channel. The first leader alone is branched. Its progress is by jerky steps of about 50 metres. Comparison with electrical records has shown that the current in the main stroke is a hundred or more times as strong as that in the leader stroke. The main stroke removes to the ground the charges lowered from the cloud by the leader and retained for a while as ionization in the channel. It may be noted that in detailed studies the timing of a leader is conveniently reckoned in milliseconds, that of the progress of the main stroke in microseconds, while the intervals between the strokes are a few hundredths of a second.

Schonland's work has been supplemented by that of McEachron, who photographed lightning striking the Empire State Building in New York and other lofty structures. The summit of the Empire State Building is 1,250 ft. above ground. McEachron discovered that, when such a high building is struck, there is an inversion of Schonland's initial process and a stepped leader travels upwards from the building. This leader is not followed at once by a main stroke; a dart leader from cloud to building intervenes. The subsequent strokes constituting the flash are of the normal type. At Pittsburgh, where oscillograms were taken showing the character of the lightning striking a tower 500 ft. high, it was found that the first leaders could be either upwards or downwards.

The most powerful currents in a lightning flash occur in the successive main strokes. The currents reach maxima of the order 20,000 amperes and each main stroke lowers a fraction of a coulomb of charge to the ground. This charge comes from the channel ionized by the leader, but many large quantities of electricity are brought down by continuing flow following the main strokes. The total discharge from a flash varies from two or three coulombs up to 100 or more. The most frequent value is about 20 coulombs.

Finally, Dr. Allibone sketched briefly theories which have been suggested in explanation of the jerky movement of leader strokes. He believes that laboratory experiments with camera and oscillograph may throw light on such theories. The potential gradient at which a flash can start has yet to be calculated.

The next subject to be considered, the distribution of electricity in thunderclouds, was introduced by Dr. G. D. Robinson. Until recently there were wide differences of opinion on this subject. The evidence available consisted of observations of potential gradient near the ground and of estimates of the charges brought down by lightning. The evidence was interpreted in various ways. To overcome the difficulties of the subject, it was necessary to develop some form of electrometer which could be carried by a balloon and sent up into the clouds. A suitable instrument, the alti-electrograph, was developed at Kew Observatory. The records obtained with this instrument indicate variations of the sign of the potential gradient by the alternation of the traces of a pair of points on a rotating sheet of prepared paper. Changes in magnitude of the gradient affect the width of the traces and exceptionally strong gradients may cause sparking through the paper.

The discussion, by Sir George Simpson and F. J. Scrase, of the data obtained with the alti-electrographs sent up from Kew in 1935 and 1936, led to the conclusion that in the typical summer thunderstorm of south-east England there is a concentration of positive electricity at the top of the cloud, a concentration of negative electricity lower down and another less widespread concentration of positive electricity near the base of the cloud. Further, it was noticed that the concentration of negative charge is always centred at a level at which the temperature is below the freezing-point. The evidence was clear that two processes were at work, one where the cloud held snow and hail, the other where the precipitation had taken the form of raindrops. The positive charge concentrated near the base of the cloud could be explained by the breaking of the larger raindrops in accordance with the theory propounded by Simpson himself in 1909. It was recognized that the process which was active in the upper part of the cloud was analogous to the electrification of drifting snow. Collisions of ice crystals charge the ice negatively and the air positively. It is the settling of the ice crystals through the air which separates the charges. Incidentally, it may be mentioned that C. T. R. Wilson pointed out in 1923, in the "Dictionary of Applied Physics", that "Simpson's explanation of the electrical effects of drifting snow would seem to imply that snow and hail clouds should be of positive polarity", but this remark seems to have passed unnoticed.

Recently Sir George Simpson and Dr. Robinson have given details of additional soundings at Kew. They have discussed anew the earlier evidence and cleared up various difficulties. The triple structure of the summer thundercloud may be regarded as well established. The structure of thunderclouds in other parts of the world must be very similar, but it is likely that in some regions, notably in South Africa, where Schonland finds a great preponderance of negative charge brought down by lightning, the positive charge at the bottom of a cloud is not so well developed as in England.

In his contribution to the discussion, Mr. J. F. Shipley dealt with the development of thunderstorms and with the character of the air currents in the clouds. He has found evidence for the existence inside a thundercloud of great eddies, like smoke rings with a common vertical axis. That aeronauts who have ventured in balloons into thunderclouds have experienced violent movements, downwards as well as upwards, is notorious. Occasionally a balloon has been carried up and down repeatedly through several hundred feet. This is what would have happened if the balloon had entered a great vortex ring. The same hypothesis accounts for the appearance of some hailstones, which have grown like apples or like miniature fly-wheels. These must have been rotating violently during their growth. It must be admitted, however, that there is nothing in the appearance of

most thunderclouds to suggest the presence of the vortex rings. Perhaps careful watching of accelerated motion pictures would reveal their existence.

Since the earliest days of wireless telegraphy it has been known that distant lightning affects the apparatus, and the hope has been entertained that it would be practicable to obtain direct observations which would be of use in locating storms with sufficient accuracy to meet the needs of the weather forecaster. Modern methods of recording and analysing atmospherics, the electromagnetic waves which proceed from lightning flashes, were explained to the meeting by Mr. F. E. Lutkin. The wave forms can be photographed with suitable apparatus, the horizontal movement of the light-spot of a cathode ray oscillograph being recorded on paper carried by a rapidly rotating drum. A high peripheral velocity, several metres per second, is needed.

There are a number of types of atmospheric. In the most frequent a series of oscillations with diminishing amplitude merges into a long smooth surge. The principal oscillations gradually lengthen, the first interval between peaks being of the order 150 microseconds and the fifth of the order 300 microseconds. The long surge lasts about a millisecond. The oscillatory movement is associated, it is believed, with the main stroke in a lightning flash, the long surge with the continuous discharge through the ionized channel.

In Australia and South Africa the peaks in the oscillatory movement have been related to the distance of origin by assuming each to be an echo, which has been subjected to a number of reflexions from the ionosphere and from the ground. In this way both the distance of the lightning and the effective height of the ionosphere can be determined.

The Australian and South African teams have both contended that the amplitude of the atmospherics can be used to measure the distance of origin. The approximation can only be very rough. The records at Slough show that the mean value of the field charge at the beginning of an atmospheric varies from 50 volts per metre at 25 km. to 0·1 at 5,000 km., but the individual values are well scattered about the means. A variation in the ratio of ten to one is often found in the amplitudes of atmospherics from a single source.

There are numerous applications of direction finding in the study of atmospherics. For locating storms two stations are required, preferably with telephonic communication; the various areas in which storms are taking place can be identified without difficulty and with reasonable precision.

The number of atmospherics received in Great Britain is greatest during the night in winter; 100 per second is a rate of frequent occurrence. These originate chiefly in tropical America. In summer, similar sources are indicated during the night hours and, during the day, there are large impulses, occurring less frequently, of European origin. Conditions are never favourable for the transmission to England of atmospherics from Africa, for the thunderstorms occur there in our day-time, when long waves cannot be transmitted.

A lively general discussion followed the four formal contributions. The outstanding difficulty in the whole subject is to explain how a lightning stroke begins. The idea that, owing to the existence of a large space charge, potential gradient increases from the ground up to a maximum at the base of a thundercloud, a maximum high enough to initiate a spark, has had to be abandoned. Very strong gradients, sufficient to cause sparking in the alti-electrograph, occur however inside the clouds, and this suggests that a flash to ground originates within the cloud and extends downward in the leader stroke process. The suggestion was made in the discussion that the trigger might be a spark between two drops, highly charged with electricity of opposite signs, brought together in their fall through the cloud.

Much interest was shown in the location of thunderstorms by radio apparatus, and it was stated that a practical application of the method has been found in the safeguarding of transmission lines. It is sometimes possible to cut out of circuit a line which passes through a region where thunderstorms are active, the instructions being sent from a central station with apparatus for determining the bearings of atmospherics.

As to apparatus required for further studies of thunderstorm problems, perhaps the outstanding need is for the development of simple electrographs which will serve to provide measurements of the strength of the field in and around the clouds. More than one type of electrograph is needed, for weak fields have to be measured as well as strong ones. A comparison of records of strong fields will serve for a satisfactory calibration of the alti-electrograph traces. The measurement of the weaker fields is especially desirable above the clouds. At present it is definitely known that the gradient immediately above a cloud is negative, so that an electric current starts upwards. Some of the lines of flow curve round and reach the ground at a modest distance; but it is believed that others go upwards to the ionosphere and carry electricity which is to return to earth in the air–earth current of fine weather. It is to be hoped that, some day, measurements of potential gradient and conductivity will be obtained well above the clouds and show whether there is an upward current strong enough to furnish the appropriate quota of air–earth current.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 21, 1941

By D. H. SADLER
SUPERINTENDENT, H.M. NAUTICAL ALMANAC OFFICE

ALTHOUGH the achievements of Dr. B. Lyot in photographing the corona without an eclipse[1] have provided an alternative method for certain spectroscopic work on the inner corona, a total solar eclipse still provides the only opportunity for observation of the outer corona, and for many other important researches such as, for example, the observational determination of the deflexion of light by the mass of the sun. The total time available for observation during totality is only a few hours a century, so that literally every second is of prime importance. That the tracks of totality may pass across the earth's surface in a band 60–100 miles wide without crossing land, or be confined solely to polar regions, together with the ever-present chance of cloud, acts merely as a greater inducement to make the fullest use of every opportunity. It is thus particularly unfortunate that the shadow of war is likely to obscure the shadow of the moon on September 21.

The eclipse of September 21, 1941, may be classed as 'about average' in regard to duration of totality, accessibility of the track of totality, and likely conditions of observation. The track passes overland for half its length, starting at a point midway between the north of the Black Sea and the Caspian Sea, passing a few miles south of Astrakhan, where the eclipse is visible shortly after sunrise, with the sun only a few degrees above the horizon; it then crosses the northern portion of the Caspian Sea and proceeds across Lake Aral into Turkestan. It passes a short distance (about 200 miles) north of the Observatory at Tashkent, but the altitude will not be more than 20° and the duration less than two minutes; even so it is a 'close approach' to an established observatory. As the track passes from Russian to Chinese Turkestan it crosses mountainous country to which access would be extremely difficult. Proceeding in a south-easterly direction the track sweeps across China, emerging at the coast almost midway between Shanghai and Hong-Kong, a few miles only north of Foochow; it passes just north of Formosa. The far interior of China is probably not readily accessible for astronomical expeditions, and in any event conditions of both altitude and duration improve towards the east; the track, however, does pass over Hankow, at which place the eclipse will occur at local noon with the sun at an altitude of 62° and with a duration (the maximum for the eclipse) of 200 seconds. It is between Hankow and the coast that the best conditions for observation will probably be found. Leaving the coast of China, the belt of totality passes out into the Pacific Ocean and the remainder of the track does not strike land, except for two small islands, (Rota or Luta Island and Tinian Island) slightly north of the important island of Guam; the southern limit of the eclipse track passes about 20 miles north of Guam itself.

It is not a very common occurrence for an eclipse to be visible from an important city, situated within a few miles of the central line of totality; it is a much rarer event, and one that must be almost unique, for a city to be within 30 miles of the point at which central eclipse occurs at local apparent noon.

Although present conditions have made expeditions from Great Britain quite impossible, it is hoped that the eclipse will not pass unobserved. It is unlikely that the Russian astronomers at Tashkent will allow an eclipse almost 'on their doorstep' to pass without making some attempt to observe it; observing conditions will not be good, however, and the difficulties of transport, combined with the overshadowing war with Germany, will not encourage a full-scale expedition. At the Stockholm meeting of the International Astronomical Union in 1938, both Chinese and Japanese delegates offered to give all facilities and assistance to astronomers intending to observe the eclipse in China; unfortunately there will now be none to take advantage of these offers. It is hoped that both the Chinese and Japanese astronomers will make an effort to secure observations, but so far no reliable information is available about any proposed expeditions.

Similarly, no definite information is to hand about American expeditions, but in view of the international tension, it must be considered unlikely that any expedition will go to China; the islands to the north of Guam (Rota Island lies well within the track) would be a possible eclipse site.

This is the second eclipse that has been partially obscured by war; the enforced absence of the European astronomers from the eclipse of October 1, 1940, was compensated by the good work of the South African astronomers, who operated instruments sent from Great Britain in addition to their own.

[1] Mon. Nat. Roy. Astrol Soc., 99, 580.

OBITUARIES

Prof. Paul Sabatier, For.Mem.R.S.

THE recent death of Paul Sabatier at Toulouse has removed from our midst one of the founders of modern catalytic chemistry. Sabatier commenced his lifelong research into problems of catalysis in 1897. The year 1900 may be regarded as the dawn of the epoch of catalytic hydrogenation, an investigation which culminated in the award of the Nobel Prize in 1912.

While Sabatier's general method of approach was from the point of view of a preparative organic chemist, nevertheless in the course of his work he showed a deep perception and thorough appreciation of the physical chemical implications. The range of reactions which he studied both by himself and with his co-workers, among whom the Abbé Senderens must be especially singled out, is truly remarkable, and a good account of them is presented in his monumental book "La Catalyse en Chimie Organique", first published in 1913 with a second edition in 1920.

Sabatier was greatly interested in the problem of hydrogenation, and showed *inter alia* that good hydrogenating catalysts were also effective in dehydrogenation; he succeeded in the difficult case of benzene in both hydrogenating it to cyclohexane and in dehydrogenating the product on the same catalyst. In his very early experiments he observed how sensitive catalysts were to heat treatment and how active catalysts could be prepared by gentle reduction of the oxides or nitrates. The use of alcohol instead of hydrogen as a reducing agent is due to Sabatier. He has put on record many interesting cases of selective hydrogenation which still await adequate explanation, such as the reduction of $\varphi CH_2\ CH_2\ CO\ CH_2\ CH_2\varphi$ to $\omega\ \omega'$ diphenyl pentane or to dicyclohexyl pentane, or amyl acetylene to amyl ethylene or to normal heptane, the former on a 'less active' copper catalyst, the latter on an 'active' nickel catalyst.

One of Sabatier's most illuminating contributions to the science lies in his discovery of directive or selective catalysis. He showed, for example, that formic acid could undergo two modes of decomposition, to carbon dioxide and hydrogen or to carbon monoxide and water; that alcohols could be converted into aldehydes and hydrogen or to ethylene and water. While metals 'favour' the first mode of catalytic decomposition and dehydrating oxides the second, there exists a whole series of catalysts on which both reactions occur, the relative extent of each reaction being dependent on the mode of preparation of the catalyst and on the temperature. This specific action of the catalyst led Sabatier to write: "La nature chimique du catalyseur exerce une action décisive dont on peut guère trouver l'explication que dans des combinaisons temporaires quoiqu'il puisse être dans certain cas, difficile d'en précisir la vraie nature." The modern hypothesis of the intermediate chemical compound or chemisorbed complex could not be expressed more clearly. That these "combinaisons temporaires" are not identical with isolatable chemical compounds could be gathered from further work of Sabatier, who was one of the first to evaluate the exact temperature coefficient and the apparent energies of activation of catalytic reactions. In many cases these were relatively small and less than those required to decompose the true chemical compounds.

Sabatier was likewise the first to pay detailed attention to what are now termed promoters; already in 1902 he investigated the effects of incorporating various oxides, for example, of beryllium, aluminium and magnesium in a nickel catalyst to obtain more active and robust systems. Among the many and varied catalytic reactions discovered by this indefatigable worker the following may be mentioned as ones which have been adapted to modern chemical industry or are potentially important: the reactions of alcohols with hydrogen sulphide and ammonia to yield thiols and amines respectively; esterification in the gaseous phase; the formation of ketones and ethers from acids and phenols. In hydrogenation reactions we may mention the reduction of the cyanides to amines and of the isocyanides to secondary amines and the stepwise reduction of the nitro group in cyclic nitrobodies.

Doubtless many of us wish that circumstances might have permitted us to solemnize in a more formal manner the departure of Paul Sabatier to a distant shore, but we can at least affirm that he has left his imperishable characteristic imprint on our science and on our industry. ERIC K. RIDEAL.

Dr. E. L. Ince

DR. EDWARD LINDSAY INCE, head of the Department of Technical Mathematics in the University of Edinburgh, died on March 16 at the comparatively early age of forty-nine. Dr. Ince, who was one of the first research students of Prof. E. T. Whittaker when the latter established a school of mathematical research in Edinburgh almost thirty years ago, had a varied life of mathematical activity. From Edinburgh he proceeded to Trinity College, Cambridge, becoming a Smith's Prizeman during the War of 1914–18. In 1918 he was a temporary lecturer at the University of Leeds; in 1919 he studied at Paris; from 1920 until 1926 he was a lecturer in mathematics at the University of Liverpool. In 1926 he was appointed to the professorship of mathematics in the then newly founded Egyptian University in Cairo, but in 1931 he returned to Britain for the sake of the health and education of his family. For a brief period he was lecturer in the University of Edinburgh, then at the Imperial College of Science and Technology, and finally, from 1935 until his death, lecturer in technical mathematics at Edinburgh.

Ince's published work falls into three parts: some two score or more papers, mostly on Mathieu functions

and on linear differential equations with periodic coefficients; a tract on descriptive geometry and two text-books on ordinary differential equations; and a volume of tables ("Cycles of Reduced Ideals") computed for the British Association, on the Tables Committee of which he served for many years.

Ince firmly believed that theoretical solutions of problems, however abstractly elegant, were incomplete unless the mathematician either tabulated the solving functions himself or rendered them tabulable. Perusal of his papers will show that in his chosen field of research he achieved both of these objects. He regarded his research, however, as entirely subsidiary to the work of teaching and of examination. To these duties he brought a rigour of self-imposed obligation which in the end was worn as a natural discipline, until ill-health supervened.

Unversed in Ince's special domain, I will not presume to appraise his papers. That has been fitly done by his master and colleague, Prof. E. T. Whittaker, in the recent posthumous conferment of the Makdougall-Brisbane Prize, awarded to Dr. Ince by the Royal Society of Edinburgh. Perhaps a more personal reminiscence may be permitted. When the "University Series" of small text-books, published by Messrs. Oliver and Boyd, was projected some three years ago, the editors invited Dr. Ince to submit a manuscript on ordinary differential equations. Soon afterwards Dr. Ince was seized by a very debilitating illness, which laid the seeds of the later and mortal one. I at once begged him to relinquish or defer the undertaking; but I was met by a quiet yet firm refusal. The book had been sketched; its outlines were clear; during convalescence chapters would be pencilled; examples would later be added. And indeed in due course the book was completed; nor does it bear any trace of the physical weakness that attended its composition.

The quiet resolution that nerved Ince to this task, as later to the completion of his last paper on Lamé functions, gives the measure of the man. He drew this courage from sources which evoke the respect and reverence of his friends.

A. C. AITKEN.

Prof. N. S. Kurnakov

BY the death of Prof. N. S. Kurnakov on March 19, at the age of eighty, Russia has lost a pioneer physical chemist whose work and influence, great in his own country, extended far beyond its borders. His early training some sixty years ago in the St. Petersburg Mining Institute must have largely influenced the trend of his subsequent work, which was mainly concerned with the applications of the principles of the phase rule to the study of binary systems, more especially alloys and salt mixtures, and with the development of the mineral resources of Russia. Kurnakov was one of the first to devise and use recording pyrometers for the thermal study of alloys and binary mixtures generally, and he was particularly interested in the variations of viscosity and of hardness which accompany changes of composition in such systems. He founded one of the chief schools of inorganic chemistry in the U.S.S.R., and right to the end of his life was director of the Institute of General and Inorganic Chemistry of the Academy of Sciences of the U.S.S.R.

Kurnakov's work, carried through with the assistance of numerous younger collaborators, many of whom are now contributing materially both to the defence and the development of Russia, is an admirable example of the fact that the development of scientific knowledge and the growth of industrial practice are closely related and largely mutually dependent. The work and ideas embodied in his treatise "An Introduction to Physico-Chemical Analysis" enabled him to play a great part in discovering and developing the resources of the salt lakes in the Crimea and on the Caspian, the deposits of potassium and magnesium in the region between the Volga and the Emba Rivers, and the deposits of bauxite at Tikhvin, upon which the Russian production of aluminium largely depends. His concern with the exploitation of Russia's resources in platinum and other noble metals led to researches on their compounds, which in turn yielded important developments in the extraction and purification of these metals.

Though little known personally to his British colleagues, Kurnakov was greatly esteemed and honoured in the U.S.S.R.: he held the Order of the Red Banner of Labour and was very recently awarded a Stalin Prize.

H. V. A. BRISCOE.

WE regret to announce the following deaths:

Prof. E. Abelaus, formerly professor of physiology in the University of Toulouse.

Dr. R. D. Archibald, formerly senior lecturer in electrical engineering in the Royal Naval Engineering College, Keyham, on August 17.

Prof. Otfrid Foerster, formerly professor of neurology in the University of Breslau, honorary fellow of the Royal Society of Medicine, aged sixty-eight.

Dr. W. Gardiner, F.R.S., honorary fellow and formerly fellow and bursar of Clare College, lately University lecturer in botany in the University of Cambridge, on August 31, aged eighty-one.

Prof. Thomas Gibson, formerly professor of pharmacology in Queen's University, Kingston, aged seventy-six.

Mr. S. H. Horgan, a pioneer in the half-tone process for the reproduction of pictures, on August 31, aged eighty-six.

Prof. R. F. Irvine, the well-known Australian economist.

Mr. W. Macnab, C.B.E., the well-known chemical engineer, technical adviser to the Explosives Supply Department of the Ministry of Munitions during the War of 1914–18, on September 3.

Prof. A. K. M. Noyons, professor of physiology in the University of Utrecht, aged sixty-three.

Dr. Vinnie A. Pease, since 1920 micro-analyst in the U.S. Bureau of Chemistry (now the Bureau of Agricultural Chemistry and Engineering), on April 30 aged fifty-nine.

NEWS AND VIEWS

The British Association: Science and World Order

FURTHER details of the meeting of the Division of the Social and International Relations of Science of the British Association to be held during September 26–28 at the Royal Institution (NATURE of August 30, p. 251) have now been issued. The aim of the meeting is to "demonstrate the common purpose of men of science in ensuring a post-war order in which the maximum benefits of science will be secured for all people".

Mr. Winant, the American Ambassador, and M. Maisky, the Soviet Ambassador, will preside at some sessions, and others will be held under the chairmanship of Dr. Wellington Koo (Chinese Ambassador). Dr. Beneš (president of Czechoslovakia), Mr. H. G. Wells, and Sir Richard Gregory (president of the British Association). Czechoslovakia, Poland, Norway, Holland, Belgium, and France will be represented, and exiled men of science from Germany, Austria, and possibly Italy, will also take part. The meeting will seek to define the part which science can play in helping to secure the best use of the possibilities of the twentieth century and to make practical contributions to problems and their possible solution.

Atmospheric Pollution

THE annual report for the year ending March 31, 1940, on the Investigation of Atmospheric Pollution, which would normally be issued by the Department of Scientific and Industrial Research, has been replaced by a summary prepared for the information of the co-operating bodies. From this it appears that the deposit over the whole of Great Britain, as represented by the deposit gauges, has decreased. The highest total deposit measured for the year (395 tons per square mile) was in Manchester, while the lowest measured (57 tons per square mile) was at Loggerheads, Shropshire; both places, however, show smaller deposits than in the previous year. There were only three complete sets of results with automatic filters: Cardiff, Coventry and Stoke-on-Trent. These are not sufficient to provide a basis for comparison with the previous year. The average monthly suspended impurity does, however, show interesting characteristics, notably maxima, in January 1940, which it will be remembered was unusually cold. This increase in suspended impurity was no doubt due to an increase in all forms of domestic heating during the cold period despite the shortage of fuel in some districts. All three places show a sharp increase in suspended impurity in October, followed by a minimum in November, although the average temperature for that month was lower than the average for the past fifty years or so. It may be that the continuation of Summer Time until November 20, 1939, and the restriction on the combustion of fuel imposed by the fuel rationing scheme may be responsible to some extent for these minima in November.

Complete results for the measurement of the concentration of sulphur dioxide by the volumetric method were obtained from the stations at London (Beckton and Crossness), Salford and Sheffield. The averages from these stations are slightly lower than those for the previous year. The measurement of sulphur gases by the lead peroxide method does not show any unusual features. Measurements of suspended impurity by the automatic filter made in Central Park, New York City, show that New York has its purest air in the afternoon between 1 and 3 p.m., while the measurements for British cities have invariably shown that the early morning air is the cleanest. This difference is no doubt due to the greater convectional turbulence of a continental climate in the day-time, resulting in a distribution of the pollution through a greater depth of atmosphere and a corresponding reduction of concentration at ground-level. Further measurements made in Dublin by Dr. Leonard have shown an interesting correspondence between concentration of sulphur dioxide and suspended impurity, the two curves for the average monthly values showing a noticeable degree of parallelism. Automatic filter results at Leinster Lawn, Dublin, indicate a ratio of domestic to industrial pollution of 3·3 to 1 in winter and 2·3 to 1 in summer.

Luminous Plastics

IN a paper by Dr. V. E. Yarsley published in the *Electrician* of August 8, an interesting account is given of recent developments in moulding materials for practical purposes. Perhaps the application to luminous plastics is the one which has attracted the greatest public interest. Having a light switch, door handle or telephone clearly visible is of real practical value for a night emergency in war-time. The layman usually associates luminescence with phosphorus or radium, and the terms luminescence, fluorescence and phosphorescence are often misused. Those substances which convert incident radiations into visible light, and not into heat, as is more usual, are called luminescent. Those materials which emit visible radiations only during the period when the exciting radiation is impinging are said to be fluorescent. The commercial luminescent materials do not belong to the radium family. They are usually metallic sulphides, more particularly those of zinc, calcium, strontium and barium. Mixtures may be used, and in some cases increased luminosity results from the addition of minute quantities of metals.

Luminous plastics may be produced either by adding the luminous pigment directly to the moulding powder or by covering the moulded article with a suitable luminous lacquer. While the latter appears the more natural method, since it requires the relatively expensive luminous pigment only in the lacquer layer, yet there are certain advantages

gained by adding the pigment to the moulding composition. A considerable amount of research has been necessary to develop a luminous pigment sufficiently stable to withstand the stringent conditions of moulding, while at the same time care had to be taken that the pigment in no way affected the chemical stability of the plastic mass. Very considerable progress has recently been made in this direction.

An interesting range of moulded luminous plastics which appeal both to the domestic user and to A.R.P. authorities is manufactured by Roanoid, Ltd., of Glasgow. These are produced in a suitable light-coloured thermo-setting plastic and include moulded letters and numerals in $1\frac{1}{4}$ in. and 2 in. sizes, and also various fittings. Cellulose acetate sheet containing a variety of fluorescent dye-stuffs in standard sheets of 56 in. by 26 in. which can easily be cut or stamped to form displays or printed signs for shop windows, cinemas and theatres are available. The ultra-violet light used for irradiation of the plastic sheet is not harmful to the eyes, since the special 'blacklamps' of 80 and 125 watts used emit radiations which have no physiological action. It is stated that while fluorescent paints lose some of their power after a few weeks exposure, fluorescent plastic sheet showed no diminution during the period under test.

Examination of Jewels in Electric Meters

THE apparatus required to measure electric power is both expensive and requires special attention. The higher the accuracy aimed at the greater is the cost of the meter, and the time and labour that has to be devoted to it rapidly increases with the accuracy demanded. To encourage the use of electricity, the Electricity Commissioners have recently allowed the testing for low-load performance to be done at one tenth instead of one twentieth of full-load capacity. Another economy they have effected is to show that an appreciable extension of the life of jewels and pivots of electric meters can often be obtained by cleaning. An article on meter jewels, their examination, grading and reconditioning, giving the recommendations by the Meter Technical Committee of the Electricity Commissioners for overcoming the present difficulties of obtaining new jewels and pivots, appears in the *Electrical Review* of August 8.

The first method described is to use a microscope with a magnification of 40–70 diameters, the stage being fitted with a simple means of holding the jewels, coaxially with the microscope and automatically positioned with the jewel cup in focus. The chief defects to be looked for are surface cracks, appearing as sharply defined straight or curved lines (parallel if more than one) on the jewel surface, and scratches from the original polishing or acquired during transport. Jewels, after examination, are classified Grade 1 jewels, which can be used immediately; Grade 2, which can be re-surfaced, showing no defects beyond shallow central wear or slight scratches within the working surface area. A pivot end that is unpolished and of bad shape must be ground to shape and polished; it should be hemispherical and never ground to a needle point. Even very slight films of dust or grease may obscure serious defects. Boiling in an aqueous solution of sodium hydroxide followed by quick drying and a rinse in commercial alcohol is said to be beneficial.

The Solar Corona

DR. DONALD H. MENZEL has an article entitled "What is the Solar Corona?" in the *Telescope* of May–June, in which he refers specially to the researches of Bengt Edlén, of Uppsala, who has shown that coronium is chiefly iron. Nickel and calcium have also been identified, the outer electrons in all these elements being torn away. Difficulties arise in explaining how the comparatively low temperature of the sun—about 6,000° C.—can be responsible for tearing away the outer electrons, the removal of which requires a temperature of at least 100,000° C. Then again, Edlén has pointed out that the great breadth of the coronal lines suggests a very rapid movement of the atoms, and a temperature of 2,000,000° C. would be required to explain this. Conclusions of a similar nature have been reached by independent lines of investigation and various explanations have been suggested to account for the source of this high temperature. The most acceptable hypothesis is that the highly heated coronal matter is issuing in great jets from holes and cracks in the solar surface. These crevices, which are probably associated with sunspots, run far down into the hot interior, where the temperature is several million degrees.

Many problems arise as a consequence of this hypothesis. Thus it is suggested that solar prominences are formed as condensations from the corona, and the motion-picture records of active prominences corroborate this view. Thousands of miles above the solar surface prominences are observed to "materialize" and to be moving downwards. They are previously invisible because their earlier high temperatures caused them to emit radiations of an unfamiliar character. The identification of the remaining coronal lines still awaits a solution and a great mystery is the tendency of coronal matter to move in well-defined arches or streamers. A possible explanation may be found in the presence of magnetic and electric fields. It is suggested that the source of electrification of the ionosphere may be found in the X-ray energy associated with the coronal emission.

Forest Administration in Malaya

THE annual report of the Malay Forest Department for the year 1939 (Govt. Press, Kuala Lumpur, Federated Malay States, 1940) is of unusual interest. A history is given of the growth of the Department from the year 1883, when the Director of Gardens, Straits Settlement, initiated a small Department. Five years later, Mr. H. N. Ridley became director and instituted a policy of Government reservation which saved valuable forests from destruction during the rubber boom of thirty years ago. As the result

of a report on the forests by the late Mr. H. C. Hill of the India Forest Service, a Burma forest officer was appointed to the control. At present, the ten States of Malaya have each a Forest Department loosely united by a common and interchangeable staff of senior European officers and an ever-increasing body of Malays trained in the vernacular school of Kepong.

In some respects the Malay States now possess one of the most up-to-date forest departments in the Empire. That this is realized by the Government is evidenced by the recent investigation into the position of forestry and mining. Mining is one of the most important of the industries and yet the interests of the mining community tend to clash with those of agriculture and forestry. Some 10,471 square miles of the States are reserved forest (about 20 per cent of the country), yet 52·8 per cent of forest land still remains unaccounted for. Much of the reserved forest is in mountainous country. The mines are mostly concentrated in the plains. Since timber is heavy and will not bear expensive transport charges, the Forest Department wishes to develop the management of the forests which are reasonably accessible—often in the neighbourhood of existing mining tracts and into which the mining industry may wish to expand. It is recognized that the mining community takes a large amount of the produce of the forests. The problem which is now being faced is to settle, if possible for a period of years, those areas which will probably be required for the extension of mining. In this the Geological Department is affording assistance; thus allowing the Forestry Department to concentrate its works of improvement on workable, because accessible, forests which will not be liable to be expropriated at short notice. The crucial point arising out of the arrangement is the obvious recognition by the Government of Malaya of the importance of the forests to the country and its inhabitants.

Venereal Diseases in War

ACCORDING to M. Schubert (*Ven. Dis. Inform.*, 22, 327; 1941), a comparison between the incidence of venereal diseases in the Prussian Army during 1903–1913 and the four years of the War of 1914–18 showed that the average incidence was 20·4 per 1,000 during peace-time and 20·5 per 1,000 during the War. Contrary, therefore, to the widely prevalent but false assumption that the incidence of venereal diseases during that War was much higher than in peace, the difference was only very slight. The only increase which did occur was in the number of cases of syphilis. Of those infected during the War 67·5 per cent contracted their infection at home and only 32·5 per cent at the front. After demobilization of the army after the War there was a catastrophic increase in the incidence of venereal disease up to 1921–22, after which date there was a gradual decrease which in 1925–26 became increasingly noticeable and was probably due to better-regulated conditions for treatment. The decrease in the incidence of syphilis was greater than that of gonorrhœa. During the past few years chancroid has been very rarely seen in Germany. During the first nine months of the present War no increase in the incidence of venereal disease has been observed except among the troops who had been in Poland, in whom the number of syphilitic infections was low and chancroid was not found.

Health of Hong Kong

ACCORDING to Dr. Selwyn Clarke, the director of medical services, Hong Kong, in his annual report for 1939, the colony's chief health problem is the large number of Chinese refugees from the Sino-Japanese War. In July 1939 the number of persons entering the colony exceeded the number leaving it by 327,833. Many of the immigrants were destitute, ill-nourished and diseased, and the overcrowded conditions in which they lived were a most serious menace to public health. The largest number of deaths in 1939 were caused by non-tuberculous diseases of the respiratory system. Tuberculosis came next, the majority of the deaths being due to the pulmonary form. 24 per cent of 1,500 refugees whose blood was examined showed a malarial infection. There were more than 9,000 cases of beriberi, 800 cases of cholera and 3,000 of influenza during the year.

Announcements

A ROCKEFELLER Foundation grant of 25,000 dollars for research in endocrinology for five years under the direction of Dr. J. S. L. Browne, assistant professor of medicine and lecturer in pathological chemistry at McGill University, is among recent gifts to the University.

A DEPARTMENT of Radiology has recently been established in the medical faculty at McGill University under the direction of Dr. C. L. Peirce, radiologist-in-chief at the Royal Victoria Hospital, and Dr. W. L. Ritchie, director of radiology at the Montreal General Hospital.

THE National Institute of Health of the United States Public Health Service is organizing a new research unit to be called the "Unit of Gerontology", which will deal with the diseases of the aged. Further information can be obtained from Dr. Edward J. Stieglitz, Investigations in Gerontology, National Institute of Health, United States Public Health Service, Bethesda, Maryland.

ON the recommendation of the Agricultural Research Council, the following awards of one agricultural research scholarship and two studentships for research in animal health have been made by the Ministry of Agriculture and Fisheries, and the Department of Agriculture for Scotland: H. E. Davenport, of University College, Nottingham, a research scholarship in helminthology; F. Alexander, of the Royal (Dick) Veterinary College, Edinburgh, a studentship for research in animal health; A. McDiarmid, of the Royal (Dick) Veterinary college, Edinburgh, a studentship for research in animal health.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Hydrological and Biological Studies of Loch Sween

IT is now many years since I directed the attention of zoologists to the excellent facilities for marine biological research afforded by Loch Sween on the coast of Argyle. In the years before 1914 it provided a delightful centre for the activities of Glasgow students of zoology during their Easter vacation. During the early post-war years Government approval was actually obtained for the conversion of one of the hospital barges used on the rivers and canals of France and Flanders into a floating laboratory, to be used as tender to the Millport Marine Station and moored for periods in Loch Sween and other west coast lochs. These plans had, unhappily, to be cancelled when economic pressure brought about the curtailment of expenditure on scientific research during the lean post-war years.

It is accordingly of much interest to myself to read in an article by Dr. F. Gross[1] of his references to Loch Sween, and I think it well to indicate two lines of investigation which to my mind deserve special attention. The first of these is an intensive study of the hydrography of the Loch—more especially of the rise and fall in the level of its waters. During my early seasons there I naturally endeavoured to construct a time table, but found myself reduced to giving up this task in despair. Tidal behaviour in the Sound of Jura outside the Loch; the local distribution of barometric pressure; the direction of the prevalent wind: all these factors played their part, but it appeared to me there must be other unknown factors, and I found myself inclined to suspect something of the nature of a *seiche*. In this connexion I bore in mind the existence of the strongly flowing tidal currents of the Sound of Jura which form a kind of barrier across the mouths of the sea-lochs opening into it and which, in the case of Loch na Cil, widely open to the south-west, is so effective as to make that loch a useful anchorage even in a south-westerly gale.

The second line of investigation is that of the origin of the fine silt accumulating in the Loch and constituting a factor inimical to the oysters which in earlier days were so abundant. During my tenure of the chair of zoology in the University of Glasgow, I kept under observation a large aquarium tank in which grew the Canadian pondweed Elodea with a balanced animal population—pulmonate Gasteropods, fresh-water Oligochaetes, Protozoa, etc. My special interest in this tank lay in its gradual accumulation of a thick deposit of fine mud of organic origin—composed of fæcal and other debris from its animal and plant inhabitants—and the interesting problem suggests itself: Is any appreciable proportion of the fine mud of Loch Sween contributed by its rich planktonic and other fauna? Dr. Hilary Moore's important studies of the mud of the Firth of Clyde might find a profitable extension to the muddy deposits of Loch Sween and other similar highland sea-lochs.

JOHN GRAHAM KERR.

Tayvallich,
Loch Sween,
Argyll. Aug. 31.

[1] NATURE, 148, 71 (1941).

Plankton as a Source of Food

THERE are several points which should be raised in connexion with the communication from Dr. Nicholas Polunin[1] in which the value of phytoplankton as plant manure is discussed. He suggests that the development of a rich growth of algæ in an open bucket or pan of water increases the value of this water as plant manure. It is, however, obvious that the only increase in total matter in the water is the carbon absorbed by the algæ. This carbon, incorporated in the algal cells, is of very doubtful value as plant manure. Growth of algæ in the water is dependent on the presence of dissolved nutrients, notably nitrogen and phosphorus salts, and the transformation of these into organic compounds does not increase their amount, or their value as plant manure, but rather the reverse, since the complex organic compounds must be decomposed by bacteria before the nutrients become available to the plants manured. For the purpose suggested, that is, the watering of vegetables, which are short-period crops, it would seem more important to add the nutrients in readily available form than to build up a reserve of organic matter in the soil. Furthermore, it is probable that there is a loss of nitrogen from the water during the development of the plankton, owing to the escape of gaseous nitrogen by denitrification or by the reaction between amino-nitrogen and nitrite. It is unlikely that any of the algæ capable of fixing nitrogen, (that is, members of the Cyanophyceæ) would grow in such tanks or buckets. It would therefore appear that the bucket of water constitutes a more valuable plant manure in its original state than it does after the development of a phytoplankton.

Figures which I obtained during experiments on the growth of algæ under conditions similar to those mentioned may be of interest. The vessels used were shallow tubs and glass tanks, open or with glass lids, heavily manured with the essential elements. Under summer conditions, a dense growth of Chlorococcales developed, but its dry weight was small in comparison with the amount of salts added. A tub of 100 litres capacity, to which 28 gm. of nutrient salts were added, produced a total dry weight of Chlorococcalean plankton of the order of 5 gm. in one month. No figures for the changes in total quantity of dissolved salts are available, but the following figures give an idea of the changes in nitrogen content. With ammonium nitrate, the decrease in ammonia and nitrate nitrogen was compensated by the increase in organic nitrogen, but in water manured with ammonium sulphate, a decrease of 15 per cent or more in total nitrogen was observed, while with potassium nitrate the decrease was 10 per cent.

It will be evident from this that the increase in humus content, which is in any event of problematical value as plant manure, is more than offset by the probable loss of nitrogen, and the certain decrease in availability of the nutrient salts.

WINIFRED PENNINGTON.

Freshwater Biological Association,
Wray Castle, Ambleside,
Westmorland. Aug. 14.

[1] NATURE, 148, 143 (1941).

Isolated Nerve-Muscle Junction

A SINGLE muscle fibre with its nerve supply (Fig. 1) has been dissected from the M. adductor longus of the frog (*Hyla aurea*). This preparation survives for as long as twenty-four hours at a temperature of 18–20° C., and electric potential changes have been recorded from some twenty of these isolated nerve-muscle junctions during activity. In most experiments the muscle fibre was kept in saline at a paraffin interface while the nerve was lifted into the paraffin and stimulated there. A 50-μ diameter platinum wire served as leading electrode at the junction and was insulated except where it made contact with the muscle fibre. It was moved to different positions along the muscle fibre by means of a micrometer adjustment. The second leading electrode was in the saline below the fibre and acted thus as a diffuse lead.

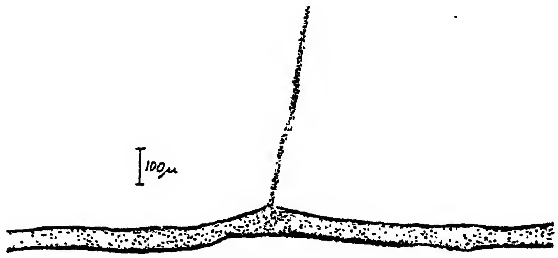


Fig. 1.

PHOTOMICROGRAPH OF A SINGLE MUSCLE FIBRE WITH NERVE SUPPLY.

A single stimulus to the nerve gives a propagated spike along the whole muscle accompanied by a contraction. Fig. 2*a* shows an action potential 0·23 mm. away from the nerve entry. Two components of the rising phase are seen; the larger and steeper one *s*, the muscle spike, which stays constant along the whole length of the muscle fibre, and an initial smaller component ε, which is only recorded near the motor end-plate (the end-plate-potential (e.p.p.), cf. Eccles, Katz and Kuffler[1]). At 150μ nearer the nerve entry (Fig. 2*b*) the e.p.p. rises much more steeply, reaching about 65 per cent of the action potential before the spike appears. With a further shift of 80μ to the nerve entry (Fig. 2*c*) the e.p.p. is so large that the spike component is barely seen rising above it. Indeed by careful adjustment the e.p.p. becomes so large that no phase of spike rise is observed. Curarization (Fig. 2*d*) diminishes the e.p.p. and the spike is delayed but not altered appreciably in total height. Below a critical e.p.p. height (Fig. 2*e*) no spike is set up and the e.p.p. alone is recorded.

Thus it can be shown that a nerve impulse gives rise at the nerve-muscle junction to a localized negative potential change as large as the muscle spike potential. This potential, in its turn, sets up the muscle spike. It decrements rapidly along the fibre and falls to about 20 per cent at a distance of 0·25–0·35 mm. from the neuro-muscular junction.

Early in the refractory period, a second nerve impulse sets up only an e.p.p. (similar to the e.p.p. in Fig. 2*e*); when later, a second muscle impulse is also set up but usually does not reach its full size until 0·5–0·8 mm. from the neuro-muscular junction. At times this impulse dies out after it has reached up to 30–40 per cent of the full spike potential and has propagated as far as 0·3–0·5 mm.

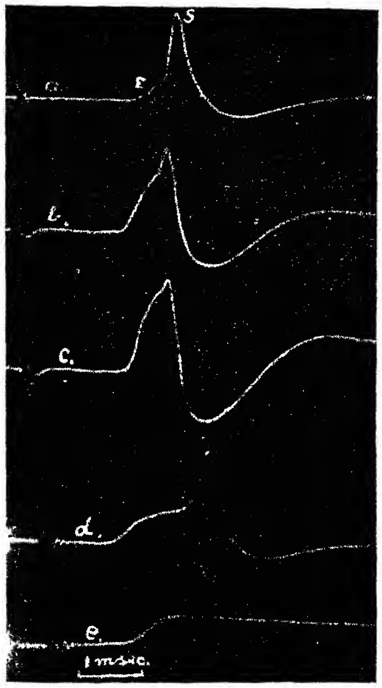


Fig. 2.

ACTION POTENTIALS. (*a*), 200μ AND (*b*) 80μ AWAY FROM THE NERVE-MUSCLE JUNCTION; (*c*) AT THE NERVE-MUSCLE JUNCTION; (*d*) SUBPARALYTIC DOSE OF CURARINE; (*e*) PARALYTIC DOSE OF CURARINE.

When recording in paraffin oil, action potentials up to 55 mv. have been obtained.

S. W. KUFFLER.
Kanematsu Memorial Institute of Pathology,
Sydney Hospital,
Sydney.
May 22.

J. Neurophysiol., 4 (July, 1941).

Effective and Ineffective Association between Root-Nodule Bacteria and the Host Plant

IN a recent paper, Chen, Nicol and Thornton[1] present results from which they conclude that "the production as a result of infection of soluble substances affecting the growth of the bacteria affords an explanation of those differences in nodule growth that determine the effectiveness or ineffectiveness of the different strains of bacteria as regards nitrogen fixation within the host".

A closer examination of the data given in the paper fails to confirm the validity of this conclusion. Controls do not seem to have been adequate, and there is no information as to the nutrients supplied in the plant juices which were added to such a high concentration (18 per cent). These omissions are the more surprising since the authors, in explaining the variable nature of their results, state:

"Composition of the root juice is liable to be affected by the growing conditions of the plant and by details in the method of extraction and filtration that are very difficult to control."

Briefly, three levels of growths were obtained in the

majority of experiments. corresponding with the following conditions and in this decreasing order :

(1) Basal medium + juice of effectively nodulated root;
(2) Basal medium + juice of uninoculated root;
(3) Basal medium + juice of ineffectively nodulated root.

However, there is no evidence to show that the nutritive substances of the yeast sucrose medium were such as to support maximum growth, namely, growth which could not be improved by extra nutrients in the medium. In fact, the one experiment which reports results with water instead of plant juices showed that the latter, even from poorly nourished uninoculated plants, caused considerable increase in growth :

	Mean Colony Areas (sq. mm.)	
	Without root juices	With juices from uninoculated plants
Mean growth, all strains	99·7	137·3

The possibility remains, therefore, that the stimulation in (1) over (2) is nothing more than the effect of an abundant nutritive supplement : a result of the effective association and not its cause.

The superior growth made in (2) compared with (3) might, at first glance, argue a case for inhibitory substances produced by the ineffective association. However, in the one comparison reported the growth in the medium containing the "ineffective" juice was no worse than that on unsupplemented medium. On theoretical grounds, it seems not unreasonable to expect the juices from roots carrying an ineffective strain to be relatively impoverished even in comparison with uninoculated controls. The parasitic organisms might well have tied up in their bodies the small amount of nutrients which would have been otherwise available to the cultivated bacteria. Again it is possible to regard the observed effect as a result and not the cause of the nature of the association.

It would seem then that, whilst the results presented in the paper are compatible with the hypothesis postulated by the authors, they do not offer sound evidence in support. At the most they seem to have shown that the root juice of an effectively nodulated plant is a better nutrient than that of an impoverished control which is, in turn, better than that of a plant the nutrients of which have already been largely utilized by parasitic bacteria.

J. M. VINCENT.

School of Agriculture,
University of Sydney,
Australia.

Proc. Roy. Soc., B, **129**, 475 (1940).

MR. VINCENT, who courteously sent me a copy of this letter before publication, suggests that the juice from roots bearing effective nodules is more stimulating to the growth of Rhizobium as a result of effective association. This is in agreement with our views. We state in our paper[1] (p. 489) that there is evidence of "an increased stimulating effect from juices of roots bearing effective nodules, possibly connected with the products of nitrogen fixation".

Mr. Vincent makes the further interesting suggestion that the poor growth of Rhizobium on medium containing juice from plants having ineffective nodules is in reality a deficiency effect, due to the removal by the bacteria in the nodule of nutrients present in the juice of uninoculated roots. The basal medium was supplied with mineral salts and carbohydrates in amounts shown by cultural tests to be in excess of the bacterial needs. Thus the stimulating action of juice from uninoculated roots was probably due either to nitrogen or to accessory growth substances. The following data were obtained from a pot experiment in which soy beans were grown in sand under conditions similar to those used to obtain the material for our root juice experiments with this plant.

Soy Beans	Nitrogen %	Nitrogen content per plant (mgm.)	Number of nodules per plant
Without nodules	1·45	16·69	—
With ineffective nodules (Strain 507)	1·73	19·34	45

The presence of ineffective nodules did not reduce the nitrogen percentage of the plants, so that it seems unlikely that the root juice will have been seriously impoverished in this respect. The root juice in our experiments included nodule juice. Some nitrogen may therefore have been locked up in the cells of bacteria retained by the filter. A calculation was made of the total volume of infected nodule cells per plant inoculated with strain 507. This gave 71 mm^3. Allowing 20 per cent dry matter with 8 per cent nitrogen this would account for only about 1 mgm. of nitrogen, the loss of which could scarcely affect the nitrogen percentage of the juice. The removal of accessory growth substances by the bacteria is an unsupported possibility. It will not explain the fact that in our first experiment with soy beans (Table I, p. 481) juice from roots bearing ineffective nodules entirely prevented the growth of one strain of the Rhizobium. The production, in the infected root, of substances affecting bacterial growth explains this and also accounts for the observation that the bacteria in ineffective nodules multiply less and last for a shorter time than those in effective nodules. This poor growth occurs in spite of the fact that the nitrogen fixed per unit mass of bacterial tissue per day is the same for the ineffective strain 507 as for an effective strain[2].

H. G. THORNTON.

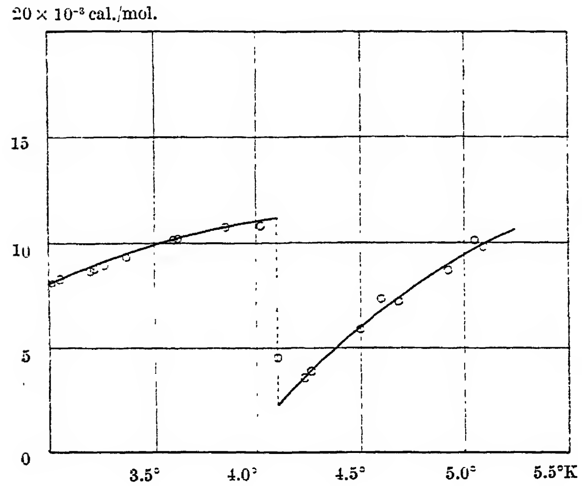
[1] Chen, H. K., Nicol, Hugh and Thornton, H. G., *Proc. Roy. Soc.*, B, **129**, 475 (1940).
[2] Chen, H. K., and Thornton, H. G., *Proc. Roy. Soc.*, B, **129**, 208 (1940).

Specific Heat of Supra-Conductive Tantalum

THE behaviour of supra-conductive tantalum is far from clear. Early magnetic and electric experiments by Mendelssohn and Moore[1], and a more recent determination of the specific heat by Keesom and Désirant[2], indicated that pure tantalum showed properties very similar to a supra-conductive alloy[3]. Further magnetic experiments by Daunt and Mendelssohn[4] on a very pure sample, however, yielded results consistent with those obtained on other pure supra-conductors.

In order to clear up this discrepancy, it was decided to carry out measurements of the specific heat on very pure samples in the supra-conductive and in the normal state. These experiments were begun in 1939 by Dr. M. Désirant, of the University of Liège, and myself at this Laboratory, but had to be discontinued at the outbreak of war. By then all measurements in the supra-conductive state had been completed. As there is no prospect of resuming this research in the near future, we feel justified in publishing a short account of these results.

The experiments were carried out on five rods of very pure tantalum, kindly lent to us by Adam Hilger, Ltd. These rods were of the same batch (Lab. No. 10679) as the one used by Daunt and Mendelssohn. Their specific heat was determined in the temperature region between 3·5° and 5·5° K. The results are given in the accompanying graph.



As can be seen, the specific heat shows a discontinuity at 4·4° K., that is, exactly at the same temperature at which the electrical resistance disappears. This temperature is also the magnetic transition point determined by Daunt and Mendelssohn. The discontinuity amounts to about 9×10^{-3} cal./mol., which is in excellent agreement with the value ($9{\cdot}5 \times 10^{-3}$ cal./mol.) calculated by Daunt and Mendelssohn from magnetic determinations. From the drifts of the galvanometer attached to the resistance thermometer we could form an opinion as to the sharpness of the discontinuity, and conclude that the drop in the specific heat occurs in a very small temperature interval, not exceeding a few hundredths of a degree.

Our results disagree with those of Keesom and Désirant[2], who found a transition region 0·2° wide between 4·0° and 4·2° K. Their results agree, however, with the experiments by Mendelssohn and Moore[1] on slightly impure tantalum. It thus appears that, in sufficiently pure and homogeneous samples of tantalum, the changes of electrical resistance, magnetic induction and specific heat accompanying the establishment of the supra-conductive state occur at one and the same temperature. The outcome of the present research thus fully corroborates the conclusion reached by Daunt and Mendelssohn that pure tantalum shows the same behaviour as other pure supra-conductors and that the anomalous behaviour observed on some specimens is due to secondary causes.

In conclusion, we wish to thank Mr. A. Horseman for his help during the experiments.

K. MENDELSSOHN.

Clarendon Laboratory,
Oxford.
Aug. 15.

[1] Mendelssohn and Moore, *Phil. Mag.*, **21**, 532 (1936).
[2] Keesom and Désirant, *Proc. Roy. Soc. Amsterdam*, **42**, 536 (1939); and private communication.
[3] Mendelssohn, Moore and Pontius, VII[e] Cong. Int. du Froid, **1**, 431 (1936).
[4] Daunt and Mendelssohn, *Proc. Roy. Soc.*, A, **160**, 127 (1937).

"The Man of Science as Aristocrat"

IN NATURE of May 3 the Right Hon. J. T. C. Moore-Brabazon states: "The man who by his political efforts can get adequate milk to children deserves more of his fellow men than the inventor of the quantum theory; but in the narrow world of science, who gets the most attention and encouragement?"

This is to me the most encouraging statement I have read respecting a definition of science. Anyone who knows human nature and the great difficulties involved in the practical proposition referred to by Col. Moore-Brabazon will realize that the desired result can only be effected, and then with extreme difficulty, by applying the scientific method patiently to attain the desired end, and the man who does it may thank God for his success.

The quantum theory is a great achievement, but the supply of milk to children, and a host of similar problems, of vital importance to humanity, can only be obtained by intelligence of the first order directed to the special practical end and by the use of the methods of science.

The conception of science and the recognition of its achievements in such directions as that indicated should rank with the achievements in the relatively narrow world usually called pure science. As Prof. Wood Jones in a characteristic sally stated: "It takes more than a white coat and a test tube to make a man of science."

If the younger men of science with the requisite ability were encouraged to strike out in these difficult and unconventional directions, we should get a better world, and perhaps such a world might recognize their achievements; at all events I think so. But the most difficult and the greatest task of which I am aware is that of altering the outlook of men. Once that is done the practical consequences follow automatically.

JAMES W. BARRETT.

103–105 Collins Street,
Melbourne, C.1.
July 19.

"Crop Damage by Air Attack."

SIR JOHN RUSSELL in his article on "Crop Damage by Air Attack"[1] says: "The most serious risk is on the stubbles, if very dry weather should set in after the harvest." For the last nine years I have used a combine harvester, and have made a practice of burning some of the straw on the stubbles after harvest. In only two years have the stubbles been sufficiently dry to burn easily. Usually it has needed several men carrying burning straw about on pitch-forks to re-light the straw, which tends to burn for a short time and then go out. I have also used a tractor drawing a chain harrow with a mass of burning straw on it to keep the fire going. A combine leaves a longer stubble than a binder, and with the straw lying on top of this it should burn easily if any stubble will. My experience is that once straw and stubble have been well wetted by rain they very rarely dry out enough for the fire to take easily.

ROGER NORTH.

Fincham Farm,
Rougham,
King's Lynn,
Norfolk.
Aug. 26.

[1] NATURE, **148**, 215 (1941).

RESEARCH ITEMS

Effects of Insecticides on the Mid-gut Wall of a Larva

THE specific action of insecticides on the tissues of various insects is a little-explored field. Knowledge of this kind may prove of value in the selection, improvement and appliction of methods of insect control. A review of the physical and chemical effects of poisons on insect tissues cells and secretions is given by Trappmann (*Z. Pflanzenkrank.*, 48 ; 1938), while the most recent contribution to this subject is by P. A. Woke, of the U.S. Department of Agriculture. In the *Journal of Agricultural Research*, 61, 321–29 (1940), this writer discusses the effects of certain insecticides on the walls of the mid-intestine of the larva of the "southern armyworm" (*Prodenia eridania*). Lethal doses of the poisons were fed to the larvæ in turnip-leaf or sweet potato-leaf "sandwiches". The subjects of the trials were then killed and fixed after different intervals and the tissues examined histologically for comparison with control individuals. It appears that the action of arsenicals was followed by disintegration of the epithelial lining of the mid-intestine and damage to the visceral muscle-fibres. Ingestion of sodium fluoride resulted in disintegration of the substance of the cytoplasm and the nuclei. The epithelial cells of those larvæ that had ingested sodium fluoaluminate were greatly disintegrated and the cross-striations of the muscle-fibres were faint or obliterated. On the other hand, no changes in the epithelium or muscle-fibres followed the ingestion of barium fluosilicate, phenothiazine or rotenone that could be attributed with certainty to the substances named. Rotenone, it may be added, varies remarkably in its toxic action on different species of insects. Silkworm larvæ, for example, died within two hours from the effects of taking in minute quantities of this substance, whereas southern armyworm larvæ readily ingested 5–10 mgm. without showing ill effects. With regard to sodium fluoride, the observation of Hockenyos that this compound can be absorbed in lethal amounts directly through the integument of cockroaches, requires fuller exploration.

Termites and Soil Fertility

WHILE the destructive role of termites in the tropics is widely recognized, another aspect of their activities has so far attracted little attention, namely their effect on the physical and chemical properties of the soil, which they are known to influence to a great extent. Preliminary investigations carried out in Nigeria (*Nigerian Forester*, 1, 8 ; 1940) have shown that the soil of an active termite heap contained an increased amount of fine particles, which tended to improve the water-holding capacity of the soil. The carbon content of a heap was six times, nitrogen content about five times, phosphorus content two and a half times, and potash content more than three times that of the normal soil. Bearing in mind the wide spread of termites in Africa and the enormous extent of their underground activities, the problem deserves a very serious study from the points of view of termite bionomics, soils, natural vegetation, crops and forestry.

Collembolan Fauna of New Zealand

J. T. SALMON, entomologist at the Dominion Museum, Wellington, has recently given an important account of these insects (*Trans. and Proc. Roy. Soc. New Zealand*, 70 ; March, 1941). His memoir is the first attempt to discover and evaluate as nearly as possible the composition and distribution of the Collembolan fauna of the Dominion named. Some 101 new species are added to the New Zealand list which makes up the total number of species from that region to 185, exclusive of sub-species. The author finds that 77 per cent of the species are indigenous and explains this fact as being due to the long geological isolation of the country. The relationship of the New Zealand Collembola with those of South America is stated to be very weak as compared with its Australian affinities. In this connexion, however, it needs to be borne in mind that the Collembola of South America have, as yet, been very little studied. Summarizing, the author finds that the Collembolan fauna of New Zealand contains an ancient cosmopolitan element represented by such genera as Achorutes, Neanura and Onychiurus. An exceptionally strong affinity is betrayed with the Australian and Indo-Malayan forms. There is also a well-marked sub-antarctic element and a few, but important and striking, affinities with the American and African regions. It seems highly probable, according to the author, that the bulk of the species reached New Zealand by land bridges, from time to time connecting that country to northern Australia and the islands north of it, and extending towards Malaya. A comprehensive work of this kind will prove a stimulus to students for studying this group of insects and also for surveying the New Zealand forms still more thoroughly. A useful aid will be found in the diagnoses of the world's families, sub-families and tribes, while the 533 figures and the bibliography will prove an indispensable adjunct. The author mentions Stewart Island, the 'heel' of the South Island and the higher alpine regions over 4,000 ft. as being likely to contain many more species of these insects, adding that they were among the localities which he has, so far, been unable to visit.

Japanese Dinoflagellates

IN his work on the Peridinians of the Diplopsalis group, Tohru Hidémiti Abé describes many varieties of plate structure ("Studies on the Protozoan Fauna of Shimoda Bay. I.—The Diplopsalis Group", *Records of the Oceanographical Works in Japan*, 12, No. 2, March 1941). These may be regarded as some of the more primitive of the thecate forms leading up to the genus Peridinium. Both northern and southern forms are in the collection studied from Asamushi and Shimoda. Those from Asamushi are almost certainly partly southern but mostly northern, and those from Shimoda only southern. There is a very great variety of plate pattern among the members of this group which Schiller in Rabenhorst's "Kryptogamen-Flora" (1937) includes in the genus Glenodinium. A further work on the same subject by Abé ("Notes on the Protozoan Fauna of Mutsu

Bay. *Diplopsalis* and its Allies", *Sci. Rep. Tohoku Imp. Univ.*, Sendai, Japan, 1941), including the strictly systematic portion and literature, is in process of publication.

Wolf-dog Hybrids

WOLVES and dogs may be crossed to give fertile hybrids. N. A. Iljin (*J. Gen.*, **42**, 359–413; 1941) has studied the segregation of characters in *X* 101 progeny of a cross (made at the Moscow Zoo) between a zonar grey wild wolf and a black sheep dog. Mendelian segregation is demonstrated for hair colour and hair pattern, eye colour, ear form, size and skull characters. There is evidence of genotypical control of tail shape, nervous disposition, time of rut, and general appearance, but environmental influences play some part. The bark of a dog is purely a modificatory character and may be easily acquired by a wolf. The origin of the domestic dog from *C. lupus* is considered possible.

Differential Response to X-Rays of Diploid and Tetraploid Barley

A TETRAPLOID barley produced by temperature shocks on the diploid Opal *B* variety has rather a low fertility due in part to its autopolyploid state and to the consequent production of offspring with aberrant chromosome numbers. A. Müntzing (*Köngl. Fysiog. Galls.*, Lund F., **11**, 1–10; 1941) has X-rayed this barley to endeavour to create differences between the chromosomes and therefore increase the fertility. In the experiments he found that the response of tetraploids to X-rays was much less than diploids. For example, 85 per cent of the expected number of tetraploids produced seeds after a dose of 15,000 r., whereas only 38 per cent of the expected diploids produced seeds. The difference is attributed to the fact that a gene hit at one locus in a tetraploid is protected by three other genes on the homologous chromosomes as compared with one other gene in a diploid.

Genetics of Galeopsis

A. MÜNTZING (*Heriditas*, **27**, 193–201; 1941), continuing his experiments with Galeopsis has produced autotetraploid *G. pubescens* and *G. speciosus*, and diploid and tetraploid hybrids between these species. It is found that hybridization between the diploid species and between the tetraploid forms are fertile, while no crosses between diploid and tetraploid forms were successful. The author was able to cross tetraploid *G. pubescens* and tetraploid *G. speciosa* with *G. Tetrahit*, which is believed to be a natural polyploid derivative of *S. pubescens* × *S. speciosa*. The possibility of repeating the synthesis of *G. Tetrahit* is thus possible. Tetraploid derivatives of different diploid individuals of *S. pubescens* show differences in pollen fertility in the first tetraploid generation.

The Pacific Earthquake of November 10, 1938

THIS earthquake has been the subject of careful study by S. M. Mukherjee and M. R. Rangaswami (*Bull. Seis. Soc. Amer.*, **31**, No. 2, 121; April, 1941). The instrumental data used were the published readings of seismograms by the observers at the various seismograph stations together with the authors' interpretation of the original seismograms obtained at Bombay, Agra, Calcutta and Kodaikanal. Using the times of *P*, the epicentre was located at 55·3° N., 158·5° W., which is some eighty miles south of the Alaskan Peninsula in the Pacific Ocean. The earthquake occurred at 20h. 18m. 40s. G.M.T. The authors state that the analysis of the *P* and *S* residuals reveals three successive shocks, the second and third occurring 7 and 12 seconds after the first. Examination of the Indian seismograms points to a fourth shock, about 20 sec. after the first. The multiple character of the shock is brought out more conspicuously when the observed times are compared with Jeffreys' surface-focus tables and corrected for ellipticity, than when compared with normal tables. The epicentres of the first three shocks are found to be the same. Mukherjee and Rangaswami considered the identification of the second movement of *P* with *sP* and *pP* and that of *S* with *sS*, but this view was found to be untenable on account of the depth of focus and the character of the non-instrumental observations. The hypothesis of 'surface focus' (that is, less than 10 km. depth of focus) appeared to fit in best with the observations used. The magnitude of the shock was found to be equal to that of the catastrophic Bihar-Nepal earthquake of January 15, 1934.

Earthquakes and Crustal Structure (Southern Pacific Region, U.S.A.)

THIS was the subject of a paper by C. F. Richter of the California Institute of Technology, Pasadena, to the Sixth Pacific Science Congress ("Earthquake Epicentres and Structure of the Pacific Region of North America—Southern Part" by C. F. Richter, Proc. Sixth Pacific Science Congress; 1939). The data used were the epicentres of earthquakes during 1930–1933 determined by J. S. Hughes and Miss E. F. Bellamy at Oxford, together with epicentres since 1933 determined by the United States Coast and Geodetic Survey, and by the Jesuit Seismological Association at Saint Louis, U.S.A. For historical work recourse was also had to the catalogues of Townley and Allen, and also of Wood, Allen and Heck for the years 1769–1933. Epicentres determined at Pasadena were also used. From all these data a map was constructed showing by separate marking the epicentres of large normal earthquakes, minor earthquakes and the few of intermediate depth in the area. The most noteworthy feature of the map was the appearance of a nearly continuous belt of epicentres following the Pacific Coast from near Vancouver Island to Panama. The important structural loop through the West Indies was much less active than the Pacific Coast, so that these seismological data do not assist in the solution of the geological problems of the exact location and character of the loop. Since 1769 three major earthquakes have occurred in California: (1) January 9, 1857, centring near Tejon Pass, with large displacements along the San Andreas fault; (2) March 26, 1872, in the major Sierra fault zone at the edge of Owens Valley; and (3) the San Francisco earthquake of April 18, 1906, with displacements along the San Andreas fault. Allen suggested a division of the fault zone into segments where the rocks are strong and fracture only under great stress, occasioning major earthquakes, and segments where they are weaker, yielding more readily and occasioning less-violent shocks. This appears to be borne out by Richter's work, which shows that as regards numbers of shocks the San Andreas fault was surprisingly inactive, especially near the regions of the great earthquakes mentioned above and near to the earthquake stations at Pasadena, Mount Wilson and Riverside.

ACCELERATION OF THE RESPIRATION OF SURVIVING TISSUE

By DR. G. D. GREVILLE
RUNWELL HOSPITAL, WICKFORD, ESSEX

THE respiration of tumour tissue in a glucose medium is increased on addition of a suitable indicator (hereinafter called 'dye') or dinitro-*o*-cresol (DNOC), decreased by a narcotic such as phenylurethane. I observed in 1936* that when narcotic and dye are added simultaneously, the respiration is only slightly less than with dye alone. On the other hand, the narcotic almost abolishes the acceleration in respiration due to DNOC. The accompanying graphs depict an experiment with the mouse tumour *MC* 2146 in phosphate-glucose. Similar results were obtained with other concentrations of narcotic, DNOC and dye.

For some years it has been accepted that: (1) dyes 'by-pass' the oxidase-cytochrome system, acting as hydrogen-transfer catalysts, being reduced by activated metabolite through coenzyme and diaphorase, with subsequent autoxidation of the leuco-dye, and (2) narcotics inhibit the metabolite-activating dehydrogenases. These principles fail to explain[1] why concentrations of narcotic which strongly inhibit normal respiration (accompanying graphs) should at most but slightly reduce the oxygen-uptake in presence of dye. As (2) was apparently so well founded, there seemed difficulty in accepting (1) as the mode of action of dyes in surviving tissues. This difficulty has recently been removed by the observation of Michaelis and Quastel[2] that a narcotic at low concentrations, instead of inhibiting those dehydrogenases which activate glucose and its breakdown products, affects the respiratory chain at some link nearer the oxidase. Dyes 'by-pass' this link, and (1) can now be freely accepted as the mechanism whereby they increase tissue respiration. In the accompanying scheme arrows denote inhibition, and 'intermediate carriers' may include any or all of the following: coenzyme, C_4-acid catalysts, diaphorase, flavoproteins, succinoxidase factor, cytochromes.

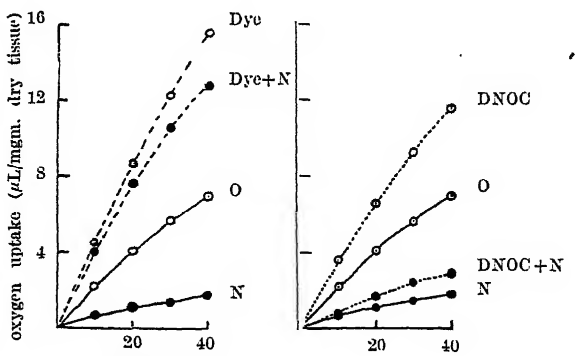
Narcotic Malonate - - - Cyanide

Metabolite | dehydrogenase | $\underbrace{\text{intermediate carriers | oxidase}}_{\text{Redox indicators}}$ | O_2

Gerard[3] suggests that in brain "the oxidase-cytochrome system does not limit the rate of oxidation, which depends on the dehydrases or their immediately related carriers". Since dyes accelerate brain tissue respiration[4], the latter is presumably either limited by the carriers nearer to oxidase, or else the 'master reaction' principle is inapplicable here, and the rate is limited by no particular link. In rat brain cortex slices, narcotic inhibition is apparently not overcome by dyes; but neither is cyanide inhibition. Indeed in cyanide-poisoned minced brain, hydrogen-transfer by cresyl blue is actually inhibited by glucose[5].

* While working in the Courtauld Institute, Middlesex Hospital, with the support of the Sir Halley Stewart Trust Fund and the International Cancer Research Foundation.

As seen above, DNOC will not restore the narcotic-inhibited respiration of tumour tissue. Several workers have noted that narcotics decrease the response of normal tissues to DNOC, and in the whole animal (cat), dial can prevent the increase in metabolic rate caused by dinitrophenol[6]. The difference in behaviour of dye and DNOC towards tumour tissue inhibited by narcotic is paralleled by their difference in behaviour when the inhibition is by cyanide[7], carbon monoxide[7] or malonate[8]. The graphs show that the link in the chain affected by narcotics cannot be stimulated or 'by-passed' by DNOC. Nitrophenols have only been shown to stimulate oxygen-uptake in intact respiratory systems. Their mode of action is still unknown. After kidney cortex slices have been subjected to anærobiosis, dyes have a reduced and DNOC an augmented effect on the respiration[1]. A speculative interpretation is that asphyxia damages the dehydrogenase end of the chain, and that this is the end stimulated by DNOC (cf.[9]). On the other hand, according to v. Euler[10] the concentrations of cytochrome oxidase and the cytochromes in tumours are strikingly low; since DNOC provokes a large respiration in tumour tissue it would have to provide hydrogen-transfer to oxygen by a cyanide-sensitive mechanism independent of oxidase-cytochrome. For this, however, there is no evidence.



O, NO ADDITION; N, NARCOTIC (PHENYLURETHANE) 0·003 M; DYE, BRILLIANT CRESYL BLUE 2×10^{-4} *M*; DNOC, DINITRO-*o*-CRESOL 10^{-5} *M*; DYE + N, DNOC + N, AGENTS ADDED SIMULTANEOUSLY IN ABOVE CONCENTRATIONS.

Difficult questions concerning C_4-acid catalysis and the path of carbohydrate oxidation in tumours, as well as the mode of action of substituted phenols, are raised by the effect of dyes and DNOC on tumour respiration inhibited by malonate. The typical experiment summarized below shows how, with glucose as metabolite, DNOC evokes a large malonate-sensitive respiration, the dye a large oxygen-uptake which is insensitive to malonate. The failure of DNOC to restore malonate-inhibited respiration is due solely to incompetence, for I have found that DNOC

in acceleratory concentrations does not inhibit the action of dye, when both are added together with malonate.

OXYGEN-UPTAKE (μL./MGM. DRY TISSUE/HR.) OF J.R.S. IN PHOSPHATE-GLUCOSE AT 38°

	No accelerator	DNOC 3×10^{-5} M.	Pyocyanine 10^{-5} M.
No malonate	11·4	23·1	26·5
Malonate 0.01 M.	8·9	9·2	23·8

The succinate–fumarate transformation must be involved in the respiration provoked in tumour tissue by DNOC, but not in the dye-catalysed respiration. Hence the route of carbohydrate oxidation in presence of dye, whether straight path or Krebs[11] cycle, cannot include the succinate–fumarate step. From its magnitude it is unlikely that the respiration in presence of malonate and dye represents a partial oxidation, and it is probable that the oxidations stimulated by dye and DNOC do not differ qualitatively. It would follow that the succinate–fumarate change involved in the DNOC-catalysed respiration is not in the path of carbohydrate breakdown, but is concerned with a catalysis of the Szent-Györgyi[12] type. Tumour tissue will not reduce oxaloacetate with any speed, either alone (Breusch[12]), or in the presence of glucose or glucose with DNOC[1]. Therefore, as Szent-Györgyi[12] has suggested, the catalysis is likely to be by the succinate–fumarate, and not by the malate–oxaloacetate, oscillation. Inhibition of the DNOC-catalysed respiration of *MC 2146* is overcome by high concentrations (0·06M.) of *l*-malate.

There is thus reason to suppose that, like narcotics, malonate inhibits hydrogen-transfer in a system in tumour tissue which is 'by-passed' by dyes but not by DNOC. As Szent-Györgyi[12] has found that in several dehydrogenations H passes to the acceptor dye through a C_4-acid system, the 'by-passing' observed in tumour tissue is not without interest.

[1] Greville, G. D., Ph.D. thesis (London, 1939).
[2] Michaelis, H., and Quastel, J. H., *Biochem. J.*, **35**, 518 (1941).
[3] Gerard, R. W., *Arch. Neurol. Psychiat.* (Chicago), **40**, 985 (1938).
[4] Dickens, F., *Biochem. J.*, **30**, 1064 (1936).
[5] Cohen, R. A., and Gerard, R. W., *J. Cell. Comp. Physiol.*, **10**, 223 (1937) (table II, p. 229).
[6] Brewer, G., *J. Pharmacol.*, **58**, 135 (1936).
[7] De Meio, R. H., and Barron, E. S. G., *Proc. Soc. Exp. Biol.*, **32**, 36 (1934).
[8] Greville, G. D., *Biochem. J.*, **30**, 877 (1936).
[9] Krahl, M. E., and Clowes, G. H. A., *J. Biol. Chem.*, **111**, 355 (1935).
[10] v. Euler, H., and collaborators, *Z. Krebsforsch.*, **49**, 46 (1939); *Ark. Kemi. Mineral. Geol.*, **13**, Nos. 6 and 8 (1939).
[11] Krebs, H. A., *Biochem. J.*, **34**, 775 (1940).
[12] v. Szent-Györgyi, A., "Studies on Biological Oxidation and some of its Catalysts" (Barth, Leipzig, 1937).

ACTION OF THE EYES IN READING

BY using apparatus similar in principle to that of an electrocardiogram, M. Luckiesh and F. K. Moss, working at the Lighting Research Laboratory of the General Electric Company, Cleveland, Ohio, have investigated the action of the eyes in reading*. One electrode is placed in the centre of the forehead, and the other on one of the temples. The feeble electric currents produced by the eye muscles are amplified more than a million times, and recorded photographically by an oscillograph. The currents obtained are so weak, and the instrument is so sensitive that electrical disturbances are likely to arise from other biological processes taking place in the patient's body, as well as from electro-magnetic waves induced in his body by electrical apparatus such as lamps.

Reading ordinary type an average adult reader traverses a line of print $3\frac{1}{2}$ in. long in about six stages or fixations. Each shift from one fixation to the next occupies about 0·03 sec., and involves an electrical charge of the order of 0·00001 volts. One fixation comprises about nine letters. Fixations themselves vary in time from about 0·2 to 0·5 seconds. They tend to become longer towards the end of a line. If one fixation proves unsatisfactory, the succeeding one may shift backwards along the line, but it usually occupies a shorter period of time.

The remarkable control exercised by the perceptual faculties over the eye muscles is evidenced by the fact that an ordinary person reads about the same number of letters at each fixation, whether the print is in 4-, 10- or 18-point type. Between fixations visual patterns do not appear to be registered in the brain cortex, so avoiding blurring. The same is true of shifts in fixation from one line to the next, which may occupy 0·12 seconds, involving an electrical charge of 0·00006 volts.

* *School and Society*, **53**, No. 1376 (1941).

The fatigue of continuous reading may be appreciated from the fact that each fixation involves the simultaneous adjustment of six separate muscles to each eye, and that both eyes must work in harmony. Each set of type characters impress a new perceptual task upon the brain, giving rise to conceptual patterns as the letters read convey their message. Records of the electrical charges taking place in the eye muscles at the beginning and end of a long period of continuous reading are not dissimilar, indicating that the muscles retain the ability to respond adequately when perceptual faculties are beginning to show signs of fatigue.

Children often make twice or three times as many fixations as an adult in reading the same amount of print. This manifests itself in the slower rate of reading, as well as in the earlier stage at which fatigue sets in.

An average educated person when reading blinks about six times a minute. Each blink occupies about 0·3 seconds, and the electromyogram indicates that in blinking the eyes shut much more rapidly than they open again. During the process of blinking the eyes are rotated inwards and upwards, and then out again to produce an entirely new fixation. It used to be thought that blinking merely served to keep the cornea moist and wash away foreign particles. Now it is known that blinking also helps to relieve ocular fatigue.

Recent investigations have shown that the frequency of blinking is reduced if conditions for good vision are improved, as, for example, by better illumination, by means of glasses, and by using more legible print. During periods of increased concentration blinking may be postponed until a less critical stage is reached, but only at the cost of an earlier onset of fatigue.

SCIENTIFIC WORKERS AND THE CHEMICAL INDUSTRIES

DELEGATES from all parts of Great Britain (Scotland, Bristol, Birmingham, Billingham, London, Liverpool, Manchester, etc.) met at a chemical industries conference called by the Association of Scientific Workers on August 31 in Manchester to discuss the achievement of maximum technical effort behind war production and the problems of scientific staffs. This conference was the first of a series covering specific industries.

Speeches from the delegates showed the need and value of such conferences. Instances were cited of highly qualified scientific workers being engaged on non-essential work while production in other places was held up for lack of scientific personnel. Specific cases were given of lack of the systematic pooling of scientific information, leading to the holding up of production, and of the fullest use not being made of the resources of existing laboratories and equipment because of peace-time methods of organization.

The keynote of the conference was expressed by the chairman that only a greatly increased production could guarantee the support to the Allied forces which could defeat Fascism. It was generally agreed that the present hindrances to full utilization of all technical resources must be removed and all other questions, including the separate interests of both employers and staff, must be subordinate to this.

The following resolution was agreed upon unanimously:

"This conference of delegates from A.S.W. branches and groups in the chemical industries after discussion finds that the co-ordination and utilization of scientific and technical man-power is not commensurate with the effort needed in the present critical phase of the war. We, the delegates, pledge ourselves to initiate a campaign for maximum production. The organized activities of scientific and technical staff through the A.S.W. nationally and locally are necessary to implement this policy. We, therefore, propose the following programme: To ensure that

(1) The present position where all technical staff are not fully utilized on work essential to the war effort is quickly rectified; (2) real pooling of technical information and facilities takes place between Government departments and industry; (3) every incentive is given to increased effort on the part of technical staff by the removal of grievances attendant on non-payment for overtime and irregular salary increments and holidays; (4) women occupying technical and scientific posts in industry receive the same salaries and opportunities as men doing the same type of work; (5) adequate training facilities be provided for inexperienced personnel to rectify the effect of transfer and enlistment of technical staff; (6) the conditions of transference be safeguarded by consultation between representative organizations; (7) A.R.P. and safety organizations be under democratic control as envisaged by Government legislation.

To carry this programme into effect we propose the following action: (1) the calling of local works and laboratory meetings to apply the programme to local conditions; (2) initiation of approaches by the A.S.W. to all organizations concerned with production including managements of firms and national and regional production boards; (3) the closest co-operation with other trade unions; (4) strengthening of the A.S.W. as representing all technical and scientific staff."

FORTHCOMING EVENTS

Tuesday, September 16

THE FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 3 p.m.—Mr. W. S. Mansfield: "The Maintenance of Land Fertility in War-Time".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER (MALE) OF CHEMISTRY AND PHYSICS in the Londonderry Municipal Technical College—The Director of Education, Education Office, 5 Guildhall Street, Londonderry (September 20).

ASSISTANT LECTURER IN SCIENCE, MATHEMATICS AND DRAWING in the Halesowen County Technical School—The Secretary, Halesowen Higher Education Committee, 21 Great Cornbow, Halesowen, Worcestershire (September 20).

REGISTRAR at the Huddersfield Technical College—The Director of Education, Education Offices, Peel Street, Huddersfield (September 30).

LECTURER IN NEUROPATHOLOGY AND NEUROPATHOLOGIST to Mental Hospitals of New South Wales—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

LIVESTOCK OFFICER—The Secretary, Land Settlement Association, Ltd., 43 Cromwell Road, London, S.W.7.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 1, No. 9: Cytological Analysis of Chromosome Behaviour in Three Breeds of Dogs. By I. A. Ahmed. Pp. 107–118. (Edinburgh and London: Oliver and Boyd.) 1*s*. [158

Freshwater Biological Association of the British Empire.) Ninth Annual Report for the year ending 33st Mareh, 1941. Pp. 54. (Ambleside: Freshwater Biological Association of the British Empire. [188

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences.) Vol. 61, Part 1, No. 6: Generating Functions of Certain Continuous Orthogonal Systems By A. Erdélyi. Pp. 61–70. 9*d*. Vol. 61, Part 1, No. 7: The Clear-Day Barometric Curve at Ben Nevis. By T. R. Tannahill. Pp. 71–76. 6*d*. (Edinburgh and London: Oliver and Boyd.) [268

Other Countries

Indian Central Jute Committee. Technological Research Memoir No. 2: The Relation between the Physical Fibre Characters and the Spinning Quality of Jute, I. By C. R. Nodder, K. R. Sen and B. K. Chakrabarti. Pp. 20+4 plates. (Calcutta: Indian Central Jute Committee.) 1 rupee; 2*s*. [148

Records of the Geological Survey of India. Vol. 76, Bulletins of Economic Minerals, No. 3: Strontium. By M. S. Krishnan. Pp. 16. (Calcutta: Geological Survey of India.) 6 annas; 7*d*. [148

Proceedings of the United States National Museum. Vol. 90, No. 3111: The Chicora (Butler County, Pa.) Meteorite. By F. W. Preston, E. P. Henderson and James R. Randolph. Pp. 387–416. (Washington, D.C.: Government Printing Office.) [158

Forest Research in India and Burma, 1939–40. Part 1: The Forest Research Institute, Dehra Dun. Pp. iii+133. (Delhi: Manager of Publications.) 3 rupees; 5*s*. [158

Smithsonian Institution: Bureau of American Ethnology. Bulletin 128: Anthropological Papers, Nos. 13–18. Pp. xii+368+52 plates. (Washington, D.C.: Government Printing Office.) 70 cents. [188

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NATURE

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COLONIAL DEVELOPMENT

WHATEVER form Anglo-American co-operation may ultimately take after the War, there are certain fields in which some continuity appears to be inevitable. Notably this is true of a whole range of questions such as the future of agriculture in the United States and in the British Empire, questions of nutrition and raw materials and colonial development. Moreover, measures already undertaken, such as the establishment of a joint Canadian-American Defence Board in 1940, the first of a series of moves towards closer collaboration between the United States and its northern neighbour, like the long-term leasing to the United States of British bases in the Caribbean Sea and on the Atlantic seaboard, can scarcely be dropped, much less reversed, on the termination of hostilities with Germany. They must affect British colonial and imperial policy as profoundly as they are modifying the isolationist attitude of the United States which has characterized the last twenty-five years.

This is indeed foreshadowed in the fourth and fifth points of the Atlantic Charter, as Mr. Churchill has aptly termed it. These points deal with the questions of access to raw materials, and collaboration in the economic field ; and they make it quite clear that Great Britain and the United States will not be parties to a world regime in which countries could be held to ransom through lack of natural products. The experience of the past twenty years has made it quite clear that policies of national self-sufficiency cannot meet the needs of humanity. Man is fundamentally a social animal ; and the progress of civilization—indeed its very existence—has come to depend on active collaboration not only between men as individuals but also between the nations. Such collaboration in the economic field is laid down in the Atlantic Charter as a principal factor in the new world order which must follow the defeat of Nazism. A nation can no longer be allowed to disregard the effect upon its neighbours of its policy in the economic and other fields.

The way in which Canada compromises the isolation policy of the United States has been indicated by Mr. John MacCormac in his recent book "Canada : America's Problem"*, in which he also emphasizes the significance of Canada in imperial affairs, and the shifting centre of gravity of the British Commonwealth. The whole tendency of present events is to accentuate the importance of Canada in the Empire, and whether or not the solution to the problems of Anglo-American relations lies in some form of English-speaking union as Mr. MacCormac suggests, his assertion that if Anglo-American relations are ever to be given an enduring basis, Canada must be their keystone, is not easily challenged. The foresight shown by Bismarck when he asserted that the

* Pp. 256 (London : Jonathan Cape, Ltd., 1941.) 10s. 6d. net.

inherited and permanent fact that North America speaks English is the greatest political fact of modern times is emphasized by all the rapid developments in Anglo-American relations of the past twelve months.

These new oceanic pre-occupations of the United States are creating new ties and a fuller community of outlook between them and the loosely knit oceanic structure of the British Commonwealth of Nations. The recent American occupation of Iceland is only one of a number of developments tending to bring the two democracies closer together in this way. Among these are the developments to which Lord Moyne referred in his statement in the House of Lords on July 9, regarding progress which has been made under the Colonial Development and Welfare Act. Already twenty-four schemes under that Act have been approved, the largest of which involves an expenditure of £200,000 for re-afforestation in Cyprus. Thirty-four more are under consideration, and at least seventy others are soon to be submitted. Full use is being made of expert help. The great majority of the new proposals are the result of the work of the Comptroller of Development and Welfare in the West Indies, Sir Frank Stockdale, formerly agricultural adviser to the Secretary of State for the Colonies, and a member of the Committee on Nutrition in the Colonial Empire.

Further evidence that careful plans are being laid for the development of the new constructive policy in colonial administration is seen in Lord Moyne's announcement of the establishment within the Colonial Office of a small official committee, with Lord Hailey as chairman, to prepare the ground for the decisions which would be needed to plan Colonial economics under the new conditions after the War, and to collect the facts that would help that Committee to deal with many other post-war problems that will arise. Since the great African Survey associated with his name, Lord Hailey has already carried out two other inquiries in connexion with African colonies of Great Britain and their relations with those of Belgium and Free France. His appointment to this new committee is clearly in line with ideas expressed last year at the Eighth American Science Congress on the fundamental conception of a world resources board and planning bureaux to promote the conservation and utilization of natural resources for the welfare of all nations in the interests of permanent peace.

The developments outlined by Lord Moyne and referred to again by him in the House of Lords on August 16, and the Colonial Development and Welfare Act are aimed at securing the economic and social development of the colonial territories. The new policy, with its recognition of the Colonies as societies, the welfare and development of which should be the guiding principles of their economic organization, and its determination to raise so far as possible the standard of living of all those classes whose standards are at present below an adequate minimum, however, also facilitates co-operation with other countries to that end. In many fields such as nutrition and health, including the attack on pests and diseases, like the rinderpest, the tsetse fly and the locust, to which Lord Hailey referred, and also in the development of an economy of mixed farming and native industry or of a constructive system of social services, we have much to gain by pooling experience and knowledge with our Allies and partners.

The foundations for such scientific co-operation already exist, and Lord Moyne's statement should give further inspiration to workers in such fields. There are, however, even more powerful factors implementing such co-operation. The prosperity and future of the Colonies must be profoundly affected by the changes brought about by the War. Quota schemes for imports from various countries, and commodity schemes which ensure various producing countries a fair share of the world market, are rapidly superseding older systems of tariffs as a means of controlling the direction of trade. Government control would involve much more than the readjustment of surpluses, and the organization of export marketing already achieved with the Colonies of our Allies must be continued in some shape. This involves a co-ordinating authority on a world-wide, a regional, or a continental basis, and the new policy accordingly seems likely in practice to involve increased international co-operation, while its spirit assists such relations.

American opinion is clearly coming to face the possibilities of framing programmes relating to colonial areas, raw materials, shipping, migration and other questions so as to remove obstacles to the full use of the world's resources, as the *Fortune* round-table discussion showed. The handling of colonial problems in the spirit of wise and far-sighted generosity which informed Lord Moyne's statement cannot fail to invoke Anglo-American co-operation in this and in other fields. The crop purchase schemes and the much larger schemes under the agreements recently made with Australia and New Zealand for dealing with the surplus produce of the two Dominions during the War, and which are to be extended to South Africa and the Colonies, are not merely designed to prevent the worst forms of distress and keep the colonial producers going. The agreements are indeed an economic necessity to the Dominions if they are to make their contribution to the War and to maintain a healthy economic life, but at the same time

they are part of a great scheme of international reconstruction.

The building up of reserve stocks of food contemplated in the agreement is concerned not only with the possibility of a long war but also with the difficult food situation that must arise when the War ends. The agreement ensures that large reserves will be available when the War ends, and these reserves will be used, in part, according to the promise of the British Government, to relieve the needs of the occupied countries of Europe. Canada stands by these arrangements because her staple food product is wheat, which will be handled at an early meeting of the International Wheat Committee in Canada. The policy, however, will be extended to Canada and by that time, as a result of the work of the Willingdon Commission, some of the South American States may also come in. Moreover, the present agreement already involves co-operation with the United States, for example, in the supply of tin-plate for meat canning, of milk-drying plant to New Zealand, while it is expected that the United States will take some of Australia and New Zealand's surplus meat as shipping is available, sending Great Britain an equivalent amount over the shorter Atlantic route. Negotiations are also proceeding with the United States for the release of refrigerator ships to be used in carrying the surplus food stocks, and other work in this field is being carried out by the Leith-Ross Committee in regard to co-ordination of storage arrangements.

We have here the beginnings of an important policy for international co-operation in handling food stocks and primary products. It needs little imagination to see how with wise handling it could develop into a far-reaching attempt to raise standards of living in backward areas all over the world, and to translate minimum standards into ideal standards on a firm basis of scientific and social research. Vision and foresight will of course be required to see that developments out of these agreements continue to facilitate common action with the United States and the Latin American republics, and do not involve Great Britain in any exclusive imperial block. The moral obligations of economic leadership must be acknowledged by Britain and the United States, if only to enable them to solve their own problems of surplus food production and economic freedom. The major responsibility may indeed well rest with the United States, but the constructive international statesmanship required is not the affair of any one nation alone.

The prospects thus opening up before us are far from being limited to the simultaneous résumé of the primary producers and the starved populations of the world. The relief of hunger is coupled with the struggle against disease, the elimination of malnutrition and the application of the knowledge of nutrition to the building of a sounder social and economic order, the reorganization of transport and the return to civil life. Here, as Mr. Winant has recently reminded us, the International Labour Organisation is still making important contributions, and a firm basis already exists for that international co-operation which is imperative if we are to deal effectively with these problems. Out of that practical co-operation may well develop by degrees the framework of organization essential in a stable world order.

The primary importance of Anglo-American co-operation and leadership should not lead us to overlook the fact that co-operation of all the free peoples is required to build a new order in which the four freedoms for which we contend are firmly enshrined. It is doubtful whether we have even yet begun to utilize to the full the opportunities for mutual understanding and for co-operation in the essential research for the organization of a new order which are inherent in the presence in Great Britain of Governments representing so many of the submerged States of Europe. One suggestion which has been advanced is the establishment in London of a social research centre on the model of the Institut Solvay in Brussels, where officials of these Governments would meet to discuss their social problems. Equipped with a library and a staff able to give expert advice in the choice of books and on sources, such a centre might do much to promote the sympathetic understanding of our respective social systems, and to stimulate investigations and co-operation which would bear fruit in the work of the International Labour Organisation.

The suggestion is one that merits serious exploration, for it could undoubtedly clear away many misunderstandings and differences. Less spectacular than the Inter-Allied meeting at St. James's Palace on June 12, it could make an important contribution to unity and to the task of world reconstruction, if not indeed to the implementing of the war effort. The opportunities and possibilities which are already to our hands through the changes brought about by the War are already so great that only the grossest bungling can fail to use them as stepping-stones to an order worthy of the sacrifices now being made in defence of freedom Nowhere is this truer than in imperial and colonial affairs, where we can attest the sincerity of our ideals and of our conception of trusteeship. There we can explore the possibilities of co-operation with the United States and the other free nations to establish economic freedom in a new way and to eliminate some of the underlying causes of war ; there, too, perhaps we may gain the experience out of which a new and adequate form of world order may emerge.

UNIVERSITY OF MICHIGAN EXPEDITIONS TO WEST GREENLAND

Reports of the Greenland Expeditions of the University of Michigan

Part II : Meteorology, Physiography, and Botany. William Herbert Hobbs, Editor. (University of Michigan Studies, Scientific Series, Vol. 6.) Pp. vii+288+47 plates. (Ann Arbor, Mich. : University of Michigan Press ; London : Oxford University Press, 1941.) 5 dollars.

THE more general reports upon the series of five expeditions to West Greenland undertaken by the University of Michigan between the summers of 1926 and 1933 are published in this volume. (Part I, which appeared in 1931, was limited to "Aërology, Expeditions of 1926 and 1927–29"; the originally planned third and fourth parts will not be published.) The present part is predominantly meteorological, but the five papers which comprise it cover such a wide range of subjects that they seem best considered separately; nor are they of similar value, or necessarily concerned with the same geographical region.

(1) *Meteorological Studies*, by J. E. Church. The first part of this paper deals with "Climate and Evaporation in Alpine and Arctic Zones", the alpine zone being the Lake Tahoe Basin lying around lat. 39° N. and long. 120° W. in the central Sierra Nevada and the arctic one being the Holstensborg region near the arctic circle on the west coast of Greenland. Useful tables indicate the rates of evaporation of water, snow and ice under different conditions; under comparable conditions in both regions these tend to be in the ratios 3, 2 and 1, though around melting-point the results are very variable and the last two figures may actually be reversed. Wind and temperature are the dominant factors in determining the rate of evaporation, which during the incidence of *foehns* may be extraordinarily rapid.

Progressing inland in the Holstensborg region the climate tends on the whole to become more continental in type, although (as in other northern regions) unusually favourable conditions are to be expected locally around the heads of the longer fjords, while on the inland ice the relative humidity is consistently greater and the temperature range sometimes lower than near the coast. Plant ecologists will note with interest that at one point well away from the coast, evaporation during the warmest two months of summer scarcely exceeded the rather low precipitation (including condensation), so that "the winter accumulation of moisture still remained in the humus and underlying blue clay as a source of growth". The protection of the soil by a "thick mat of tundra" reduced evaporation ("including that amount transpired by the tundra") to 63·1 per cent of what it was from open water, which "shows vividly the xerophilous . . . character of the Arctic tundra".

The second part of the paper deals with "Temperatures of Arctic Soil and Water", the studies indicating that inland in West Greenland "the soil rather than the icecap is the cause of the low water temperatures which prevail, aided somewhat by supercooling at night", for "frost . . . exists even at the end of the season at the depth of 16 to 23 inches beneath the surface". Seawater temperatures are variable locally, depending on currents (themselves affected by winds), proximity to the shore and to icebergs, etc., as well as on the season; on the whole they are little lower in north-central than in south-central West Greenland.

(2) *Report of the Northern Division of the Fourth . . . Expedition*, 1930–31, by William S. Carlson. This paper is again in two parts, the first of which describes detailed aerological and meteorological studies made near the inland ice east of Upernivik (lat. 72° 47′ N.). Numerous pilot balloon flights showed that the mean monthly velocity of free-air wind increased steadily with altitude from 250 to 2,000 metres, this increase on the average totalling more than 100 per cent. At higher altitudes there were further, but less regular, increases until 8,000 m. was reached, and then a marked tendency to decrease around 10,000 m. Calms were very few above 250 m. and none was observed above 2,500 m. Wind direction also changes chiefly in the first 2,000 m. Detailed studies of four storms when correlated with published observations made synchronously in other parts of Greenland, at sea and abroad, bring to light remarkable local variations but further confirm the general belief that the 1,600-mile-long ice-cap of Greenland "exercises a dominant control in the weather of at least a part of the Northern Hemisphere", for "it impedes the natural progress of some storms, redevelops energy in others and is responsible for their inception".

The second part of the paper is on the geology and glaciology of Upernivik Fjord and the region northwards to Inugsulik Bay. It is based largely on observations made during travelling under winter conditions and is accordingly rather sketchy. It appears, however, that the fronts of some of the glaciers in this region have receded as much as 2,000 or even 5,000 ft. since the visit of Ryder in 1886–87, and that in this interval fresh nunataks have emerged. The large glaciers which come from the ice-cap, dissecting the ice-free coastal strip and calving actively into the sea, show the greatest rate

of flow around their centres, the velocity decreasing towards the sides. On the Upernivik glacier the much greater maximum velocity (67·44 ft. in twenty-four hours) observed in April 1931 than in April 1887 suggests that Ryder's claim in excess of 100 ft. in twenty-four hours might be exceeded during summer on this glacier nowadays, as the summer rate is liable to be considerably greater than the spring one.

(3) *Meteorological Report of the University of Michigan – Pan American Airways Greenland Expedition, August* 1, 1932–*July* 31, 1933, by R. L. Belknap. This was the fifth and last expedition of the series and also functioned as one of many units making investigations during the "Second International Polar Year". It was based on Nugssuak Peninsula, in the northern part of the region described in the last paper. The lowness of the average daily air temperature (less than 10° C. in all months) was attributed to the modifying effect of the inland ice near which the station was situated, although very rapid changes in temperature and pressure occurred especially in relation to storms when the wind sometimes exceeded 100 m.p.h. The results of previous expeditions were confirmed by the observations that "the southeast winds were the most frequent and were of the highest velocity", and that although storm effects were often remarkably local the major disturbances were in Greenland first observed in the extreme south, whence they apparently "traveled up the coast on both sides" without crossing the ice-cap.

(4) *Physiographic Studies in the Holstensborg District of Southern Greenland*, by R. L. Belknap. In this region, which is unusually dry, the ice-free marginal land is wider than elsewhere in West Greenland, being up to 110 miles in width although still dissected by fjords and valleys. The outer coast is rugged and mountainous but the country inland, which is uninhabited and less known, is of rounded hills and numerous lakes of all sizes. The topography appears to support the theory of fjord origin by glacial erosion guided by joint systems rather than by the enlargement of fractures chiefly by stream action. Shells of recent marine animals found on terraces more than 100 ft. above sea-level indicate a corresponding rise from the sea in relatively recent times. Previously this district, like other parts of Greenland, had been one of great submergence ; now there are some suggestions of slight submergence again. It is reported as "evident that the entire area as far as the present coast line has been covered by the icecap". Wind is an important agent of erosion and deposition ; it may considerably affect the shape of a boulder (rock not specified) in a single year. The importance of solifluxion is also noted but the "explanation of the formation of soil and rock polygons" was surely not "worked out" satisfactorily by the few authors cited.

(5) *The Vascular Plants of an Inland Region within the Holstensborg District of West Greenland*, by Carl O. Erlanson. This last and shortest paper is most disappointing. The area concerned is a limited one at the head of Söndre Strömjord, occupied chiefly by low, rounded hills of gneiss interspersed with small lakes. But the ecological notes on "Vegetational Aspects" are scrappy and studded with doubtful statements and unwise generalizations, while the "Systematic List" which comprises most of the paper contains many inaccuracies. We are even told on p. 265 of *Cassiope tetragona* that it "may become a dominant plant over large areas, sometimes to the entire exclusion of other species except mosses and liverworts" and on p. 273 that it is "Rare. A bog plant" (which it is not characteristically in any of a dozen arctic and subarctic regions known to the reviewer). There are other instances in which the citation of the habitat of a single gathering of a species in the systematic list is misleading, while a glance at any part of the paper will show that the nomenclature is badly out of date. A footnote informs us that this contribution was "prepared and submitted for publication in the spring of 1929". Since then arctic botany has advanced so enormously that a large proportion of the names used in this paper are wrong or doubtful and most of the records claimed as particularly significant are no longer so, if indeed they ever were. The result is a plethora of inaccuracies the majority of which would have been questioned by a competent plant taxonomist or phytogeographer.

One lays down the volume with rather mixed feelings. Obviously much useful fact is recorded in it, often for the first time ; obviously, again, the editing leaves much to be desired. The numerous photographs are usually good but their subject is not always significant. There are more than the apparently inescapable minimum of omissions and inaccuracies, as well as inconsistencies and unwarranted generalizations, while whole "lines" of literature were persistently neglected by the authors, including much that has been written about the Canadian side of Davis Strait and Baffin Bay. Had the investigators realized that central West Greenland is only a small part of the great arctic checkboard, many of their conclusions would have been less sweeping. The impression, then, is one of youthful enthusiasm rather than mature scholarship ; nor do the total results compare favourably with those obtained by some other recent northern expeditions which had much more limited resources in time, personnel and particularly money. NICHOLAS POLUNIN.

A NEW DEAL IN EDUCATION

Education for the People
By Dr. F. H. Spencer. Pp. vii+306. (London: George Routledge and Sons, Ltd., 1941.) 7s. 6d. net.

TOTAL war is accustoming us to the necessity for radical changes in the pattern of our society. After the War we shall not be able to go back to our old way of living. We may try to reinstate the old order, leaving it to the inevitable next cataclysm to teach us what the present one fails to do, or we can go forward with imagination and resolution to create a new order. The first few years after the War will be crucial. Will the resolution we are showing now be spent, or baffled, as it was after the War of 1914–18, or will it carry us on to the creation of a new pattern of living in which war will not be inevitable? The decision depends a good deal on people thinking now what we shall have to do. Some people are thinking now, and though we are not yet within sight of winning the War, it is not premature to be doing so. In the field of education, the officers of the Board of Education have their plan of reconstruction, but for not very convincing reasons it remains a secret plan. Dr. Spencer does a public service by making public now his plan for a 'new deal' in education.

It is symptomatic of the attitude of our people to education that the developments Dr. Spencer demands are so far-reaching that, if the experience of the years after the last War is a guide, we shall have to struggle very hard to secure them, and yet at the same time they are not nearly radical enough to meet the situation. Dr. Spencer's proposals are not revolutionary. He advocates courses of action which the better local education authorities, the teachers and others have been urging for years. We must, of course, see that nursery schools are available for all children of nursery age and not merely for a few thousands of them, and that enough teachers are trained to staff the schools. The size of classes must, of course, be reduced from forty or fifty and more to thirty or less. The Hadow reorganization, still left half done after fifteen years, must be rapidly completed. School buildings, eighty per cent of which Dr. Spencer asserts to be out of date, must everywhere be brought up to the more generous and efficient standards of our best examples. The school-leaving age must be raised—Dr. Spencer says to fifteen—and adolescents must make the transition to full-time employment through a period of half-time attendance at day continuation schools up to the age of eighteen. Every boy and girl whose potentialities can best be realized by education of the secondary school kind must be enabled to go to a secondary school without fee. Children must have the safeguard of a medical examination, not at intervals of several years but annually; the insurance companies know the advantages of this, the Board of Education, too, must see them.

These proposals are literally modest ones in relation to the reasonable needs of our children and our country. The case for them, argued so convincingly by Dr. Spencer, may be regarded as established, and their fulfilment is now urgent. In war-time we are carrying out far bigger schemes with far more urgency, and at a far greater cost than anything Dr. Spencer requires. To meet our immediate educational needs, Dr. Spencer requires mainly capital expenditure of £100,000,000 on new buildings in the next five or ten years, and a doubling of our present small annual expenditure on the maintenance of education to £100,000,000. He requires further that the President of the Board of Education should be "a first-rate statesman of real eminence and power". (The publication of Dr. Spencer's book, by the way, has not been speedy enough to keep pace with the changes in the presidency, and the "administrative grandfather" of his president is already a great-grandfather.) Other requirements are a real Board of Education with 'guts' and an active and informed local electorate.

It is a paradox that to many a man in the street this new order will seem visionary and impracticable, while to many who believe they discern the causes of our present discontents it will not seem a new order at all. The ignorant and the faint-hearted will consider education lucky if it gets so much: those who know that our society cannot merely be patched up will want to shape the things to come more boldly and more creatively than Dr. Spencer. They will, for example, think him somewhat timid in not raising the school-leaving age to sixteen for the boy of average ability, as it already is for his more intelligent fellows in the secondary school and his less intelligent ones in the special school. They will be unimpressed by the demand for juvenile labour, and will not consider the time necessary for the more intelligent to reach the modest standard of the School Certificate too long to prepare the less intelligent for the difficult and responsible business of living in a world of great social and economic as well as scientific complexity.

Dr. Spencer insists, and all students of education

and of society will agree that he rightly insists, that an educational system always shares the characteristics of the social system of which it forms part. He insists, and all democrats will agree that he rightly insists, on equality of opportunity in education. He does not make it clear that he sees there can be no equality of opportunity in education unless there is at least a much closer approximation than at present to equality of opportunity for the enjoyment of the goods of life which our society renders possible. The opportunity in which Dr. Spencer demands equality is the opportunity to be trained to take part in a highly competitive struggle which results in very unequal opportunities for security and the enjoyment of what life can offer. As long as the arena is open, the junior and even the infant schools will train their children for the scholarship examination, the secondary school will train its pupils for the privileged position which the School Certificate confers. The senior school may achieve parity of status with the secondary school, in the size of classes and the qualifications of teachers; but parents are not much interested in the size of classes or the qualifications of teachers; they send their children to the secondary school, if they can, because they know that that way lies a more secure, a better-paid and more socially esteemed kind of job. The implications of Dr. Spencer's two propositions, indeed, go deep. If we follow them without flinching we shall find that in our new deal we shall have to reshuffle the hands more thoroughly than Dr. Spencer suggests.

R. A. C. Oliver.

TENDENCIES IN BIOCHEMISTRY

Annual Review of Biochemistry
James Murray Luck, Editor; James H. C. Smith, Associate Editor. Vol. 10. Pp. xi+692. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1941.) 5 dollars.

It has become increasingly difficult to escape from the War. Our daily life, our friends, the newspapers are full of it; it pops up in any book we get from the library, and our last random selection from our own shelves was the Trojan war on which, according to gossip, much of our strategy is still based.

The "Annual Review of Biochemistry" brought us a breath of fresh air from California. We were able to picture the Stanford University in its jewelled setting as we saw it, not bombed and in ruins in defence of freedom of thought and action. Even so, the editors complain of delays and irregularities and contributors are less international.

This is the tenth year of this valuable volume, and we have grown to wonder how we ever got on without it; perhaps because the output of papers was much smaller. Apparently nothing can now stop the publication of individual experiments as scientific papers, and the old-fashioned complete paper is a thing of the past. No one can keep up with the literature as a whole; someone has to write summary articles in each particular field; someone else has to write a section in an annual report. In these some degree of criticism and selection is exerted, whereas in the large dictionary-like compilations the editor puts in all he can find and leaves the reader to take his choice and select the grist from the chaff.

Before long it may be impossible to publish an abstract of every paper both on the ground of cost and unwieldiness. But nothing will stop the writer of scientific papers.

There is progress on every front in biochemistry. It is akin to the discovery of a new continent fertile with running streams: the covered wagons of investigation are well equipped. Progress is largely in detail, the great truths will emerge later when the ground is cleared. For example, a great deal has become known about biological oxidations and reductions, a subject which would be easier to understand if its followers wrote in English instead of shorthand. This, alas! must be a universal criticism.

More enzymes have been purified, but there has been little real progress. A lot more is known about the polysaccharides and, as was to be expected, now that a definite search is being made for these a very considerable number has been discovered. In a year or so it will be possible to say whether Nature, besides its main products of cellulose and starch, joins up the odds and ends as she listeth, or whether any definite relationship, as the polymerized molecule grows larger and larger, is to be observed. Much interest is attached to alginic acid, the polyuronide from common seaweed, which is likely to be of very considerable industrial importance, and may be eventually made on a large scale. The presence of the acid groups in the molecule gives the chance to make a range of salts of varied properties.

It is being realized that we do not know nearly enough on the chemical side of the amino acids and of the constituents of proteins. Such work is

laborious, and has been out of fashion, but it is being taken up again. Real progress is being made with the study of phosphorylase, the enzyme responsible for the reversible conversion of glycogen or starch into glucose. The reviews make little mention of the synthesis of starch from glucose phosphate in this way achieved by Hanes at Cambridge: it is the most outstanding piece of work of the last year or so.

Hormones and vitamins still cause the publication of thousands of papers: it is to be doubted whether Lord Woolton reads any of them. Here and there is progress, also much doubtful work; it will require another ten years work to see the plain where the trees once stood in this subject; the reports give them 150 pages.

Nutrition is the subject of greatest importance to-day and to-morrow, and there is just a chance that something of real value to the peoples of the world may come out of the work. There are good reviews on nutrition of man, animals and plants, including the burning questions of soil deficiencies and minerals. These are highly controversial questions, and the practical farmer does not always accept the conclusion of the scientific worker. If only the excreta of the petrol engine were of value to the land all would be well—otherwise, according to some, we must be prepared to return sewage to the land or find out how to make humus on the largest scale. There is need for many years of experiment and for critical examination of the results, but the subject is so important that both zealous workers and the necessary ample funds are likely to be available in many countries.

We have a final plea to the editors, namely, that the writers of each section of the report should preface it by a paragraph or two indicating the chief achievements and tendencies in the subject Apart from easing the task of the reviewer, such would appeal to almost every reader of the sections in which he is not an active worker.

E. F. ARMSTRONG.

DEFICIENCY SYMPTOMS IN PLANTS

Hunger Signs in Crops

A Symposium prepared by George M. Bahrt, Bailey E. Brown, Arthur F. Camp, H. D. Chapman, H. P. Cooper, O. W. Davidson, Ernest E. De Turk, George N. Hoffer, Henry A. Jones, James E. McMurtrey, Jr., Edwin R. Parker, Robert M. Salter, George D. Scarseth, Joshua J. Skinner. Edited by Gove Hambidge. Pp. xii+327+79 plates. (Washington, D.C.: National Fertilizer Association, Inc., 1941.) 2.50 dollars.

UNHEALTHY growth of crop plants, apart from trouble induced by diseases or pests, is usually associated with physiological causes, which in some cases imply excess or deficiency of various substances utilized in the metabolism of the plant. The relative quantity of these substances is immaterial, as the plant suffers as much from a deficiency of an element such as boron, of which only a minute trace is required, as from a deficiency of a major element, such as nitrogen, required in large quantities. In practice it is deficiency rather than excess that is most likely to occur, and various signs and symptoms present themselves.

Only by careful and accurate observation and experiment is it possible to ascertain the meaning of these symptoms, and considerable experience with any one crop is needed before the observations can be systematized and set out for the guidance of the ordinary grower. Work on deficiency symptoms or "hunger signs" has been carried out by a large body of scattered observers on a considerable variety of crops. In the volume under review investigators with special knowledge of certain crops or groups of crops have epitomized the present state of our knowledge of the known deficiencies for those particular plants. Major and minor nutrients are all considered, and the symptoms, cause and ameliorating treatment are discussed.

The range of crops covers tobacco, cereals, potato, cotton, vegetables, deciduous fruits, legumes and citrus, thus giving a comprehensive survey of the position with regard to the chief world crops. Many illustrations are given in black and white and in colour. As is usual with colour photographs these need careful interpretation, for it is easy for a non-expert to be misled into attributing hunger signs to the wrong element, especially if a bias exists in favour of any particular nutrient. If this is borne in mind the illustrations provide an extremely useful guide and fill a want that has long been felt by workers in this field. A key to the plant nutrient deficiencies is given for most of the crops, which provides an excellent supplement to the illustrations. The citation of references is wisely restricted to a small number specifically associated with each crop.

Altogether, the committee on fertilizers of the American Society of Agronomy is to be congratulated on the production of a volume which will prove specially useful as a laboratory guide for all workers on plant deficiencies, as well as an illuminating text-book for growers and for students of plant life.

W. E. BRENCHLEY.

SCIENCE AND WORLD ORDER

By SIR RICHARD GREGORY, BART., F.R.S.

AT the Cambridge meeting of the British Association three years ago, a new Division for the Social and International Relations of Science was constituted. Since then the full forces and resources of science have been used to devastate the civilized world. Responsibility for the discovery of these powers of destruction must be accepted by men of science, but communities and Governments decide how they shall be used in purpose and policy. No limit can be seen to such powers, and no end to the horrors they present to human life, when exercised without regard for its sanctity.

Whether scientific knowledge is used for social betterment or to make civilization a mockery depends upon statesmen and not upon men of science, who, however, alone understand its possibilities. It may not be necessary to have intimate acquaintance with such knowledge in order to anticipate effects of its applications, but it is obviously desirable for statesmen and administrators to have full appreciation of its powers. Without such understanding and insight, no social structure can be made secure against disruption.

The Conference on Science and World Order, to be held at the Royal Institution, on September 26–28, will deal with a few relations of science to government, administration and other agencies concerned with constructive planning for the present and the future (see NATURE, September 13, p. 311 and p. 338 of this issue). In the main, the point of view will be that of world resources and human needs generally, and not those defined by geographical or political boundaries. Distinguished ambassadors and other leaders in close contact with governmental authority will participate in the conference, either as chairmen or contributors of papers. It is believed that the conference will thus promote social and international contacts of far-reaching consequence.

Science is responsible for the discoveries of these powers, and engineering for their applications. Knowledge of this kind, referred to use or action, determines the material shape of civilization. It is available to the whole world for work and thought; either to increase the amenities of human life everywhere or to bring misery and violent death to the peoples of the earth. We see to-day the devastating effects which scientific discovery and invention can have upon civilized life when their might is made the sole arbiter of right. The acceptance of this claim means the rejection of all ideals of human fellowship, and reversion to conditions of the jungle.

Schemes of social reconstruction naturally differ for different places and peoples: but they should all be capable of fitting into a world framework. This means planning in an international instead of a national spirit, while giving every nation or community full opportunities to develop in its own way, provided that the common end is the betterment of conditions of life.

When civilized peoples agree to unite in such a commonwealth in which each group is autonomous, without conflict of general purpose, we may hope that the world will be saved from the dangers which now threaten to destroy it. Man has shown himself capable of rising above his animal instincts by his activities in many directions, and, wisely guided, he can use the gifts of scientific knowledge as agencies of good instead of instruments of evil.

In the terrible conflict in which many nations of the world are now engaged, there can be no doubt as to the side upon which the true spirit of science is fighting. Men of science would be false to their traditions if they failed to defend their pursuit of knowledge from the forces which now assail it. They are united with all free citizens of the world concerned with progressive human development in resisting such attacks and eliminating the evil influences which make their achievements diabolic instead of divine.

The commonwealth of science is a true democracy, in which no distinctions of birth, race, or geographical boundaries are recognized. It cannot tolerate the use of force to exclude members of any communities from belonging to its fellowship, or to deprive any citizens of their fundamental human rights. The democratic principles of science are much the same as the scientific principles of democracy, and free men of science everywhere can subscribe to them.

A declaration of these principles will be made at the close of the conference. It accepts for science the world outlook embodied in the declaration of the rights of man of the Sankey Committee, advocated by Mr. H. G. Wells, and its spirit is the same as that of the momentous Anglo-American statement of peace aims, though it does not pretend to be of the same significance. The cause in which all such declarations are made is that of all humanity. It is the cause of progressive civilization and can be attained only by action in which wisdom is combined with knowledge.

PARACELSUS (1493-1541)

By Prof. J. R. Partington, M.B.E.

PHILLIPUS THEOPHRASTUS BOMBASTUS VON HOHENHEIM, who afterwards assumed the name Paracelsus to indicate that he believed himself as great a physician as Celsus, was born towards the end of 1493 at Einsiedeln in Switzerland, then part of Germany. His father was a practising physician of repute and his teaching laid the foundation of the medical career of the son. Of the early life of Paracelsus nothing is known beyond conjecture until 1526, when he appeared at Strasburg as a physician, described as doctor and admitted to citizen rights and to a Guild of Surgeons. He studied medicine, but it is not known how. In his writings he emphasizes that he got most of his useful knowledge from artisans and from the humbler assistants of the medical profession, whom he rates higher than the schools. On the other hand, he also once stated on oath that he had become a doctor of the University of Ferrara, and it is difficult to understand his short-lived official appointments unless he was properly qualified. Besides his medical knowledge, Paracelsus also says he had great experience for a long time with many alchemists and metallurgists, and he undoubtedly visited many mines and smelteries in his travels some time about 1514. These travels probably took in most European countries, including England, at various times, but those further afield are doubtful.

The information Paracelsus acquired from the miners and alchemists seems, from what he says of it, to have been fairly superficial and such as could have been picked up by almost anyone in conversation. It would, however, have suggested to him the possibility of using metallic preparations as remedies. If he did study in Italy this would have provided a direct source for some features of his teachings, since his so-called philosophy is a mixture of German folk-superstition with the thaumaturgic elements of Neo-Platonism, then popular in Italy by reason of its revival by Ficino. The view that Paracelsus himself was the originator of the use of chemical remedies is quite mistaken, since this had been gaining ground since the time of Arnald of Villanova, who died nearly two centuries before Paracelsus was born.

While at Strasburg Paracelsus must have enjoyed more than a local reputation as a physician, since he was sent for by Frobenius, the celebrated publisher of Basle, whose illness had resisted the attempts of the physicians of that town to effect a cure. Whatever else may be obscure in the life of Paracelsus it seems quite certain that he was able to relieve diseases the curbing of which was beyond the powers of the regular medical system. It also seems probable, and is directly asserted by Boerhaave, that Paracelsus's medical fame lay in his skill in surgery and in his daring use of remedies, including chemical remedies, which were outside the list of those permitted to the physicians of his time. He was able to effect at least a temporary cure of Frobenius, and by the influence of his patient, and of that of Œcolampadius (who was professor of theology at Basle) and of Erasmus, who was then staying with Frobenius, Paracelsus was appointed professor of medicine at Basle. There is no evidence that he lectured there on chemistry.

For various reasons the stay at Basle was a short one. Paracelsus gave offence by lecturing in German instead of Latin, by abusing the old medical authorities and ridiculing—even it is said publicly burning—their writings, and by litigation with influential persons about his fees. After two years he was forced to leave Basle in disgrace. Thereafter much of his life was spent in precarious circumstances and in moving from place to place. He seems, however, often to have been treated with respect and to have enjoyed the acquaintance and hospitality of prominent citizens, but he also experienced poverty and met with contumely and contempt, which he knew how to return in kind. His arrogance and violence are beyond doubt, but these should not influence us in forming an estimate of his ability or in seeking for evidence of his solid achievements. He constantly emphasizes the futility of mere professional ritual, and in contrasting the silk-clad doctor spending his time cultivating the benevolent interest of the influential, with the alchemist working in his laboratory in a leather apron, he pointed the way which so many since his time have found it necessary to tread if any real progress is to be made. His insistence on the experimental method as contrasted with reliance on tradition is clear, and he is justly regarded as one of the great reformers of medicine.

After his official position came to an end, Paracelsus seems to have spent much of his time writing, and several important works were published in his lifetime. After his death, what were regarded as his genuine works were collected and edited by Huser and published in ten volumes during 1589–1591. This edition is the basis of all later ones and was prepared with unusual care and skill.

The whole works have recently been edited by Sudhoff, the foremost authority on Paracelsus, and at least fourteen volumes of this edition have appeared. Besides his genuine works there are several, mostly of an alchemical or mystical character, which are regarded as spurious, and it is on the basis of these that many unfavourable estimates of his character and beliefs have been based. In his case, however, apparent contradictions in separate works have little weight in deciding their authenticity. Apart from editions of his works there has been a really tremendous literature on Paracelsus, and a Paracelsus Society was recently established in Germany. A summary of the literature on Paracelsus and an appreciation of his contributions to science have recently been given by Dr. A. F. Titley in *Ambix* (the journal of the Society for the Study of Alchemy and Early Chemistry; 1, No. 3; 1938).

The reasons for this great interest in Paracelsus are various. The historians of medicine turn to a study of the reformer, whose violent methods recall and were probably modelled on those of his contemporary and countryman Luther. The historians of chemistry are anxious to find some justification for the claims that Paracelsus was of importance in their science. Those wider circles interested in the occult and superstitious find in his chaotic writings, not excluding the spurious ones, much of interest in their field. The man himself has formed the subject of poetry and romance.

The genuine writings of Paracelsus which appeal especially to the historian of science are the "Archidoxa" (of which an English translation appeared in 1663) and the "De Natura Rerum", which contain much of interest but nothing which can reasonably be said to constitute a definite advance in scientific knowledge. They emphasize that the main task of alchemy is not to make gold and silver but to prepare powerful remedies, and this certainly had a good influence on the development of chemistry and pharmacy. Many new mineral remedies, such as preparations of antimony, appeared as a result of this redirection of effort, but it has been emphasized above that Paracelsus had precursors in this field. An important feature of his teachings was his insistence that from a large bulk of inert material there could be extracted some small potent quintessence or arcanum in which the virtue of the medicine is concentrated (a view which is emphasized in the "Alchymia" of Libavius in 1597), but this idea again is to be found in the works of Arnald of Villanova and in the treatises attributed to Raymond Lully. The great stewpans of broths and messes of the Galenic and Arabian medicine gave way after Paracelsus's time to the small stoppered phials of the chemical pharmacist, and if some of these, with their arsenical and mercurial contents, were to wreak havoc in the hands of less-skilled practitioners, the ultimate gain was real and permanent. Many of his younger followers were men of great ability and he certainly inspired much valuable and enduring work in chemical pharmacy.

The writings of Paracelsus are very difficult to read and more difficult to understand. They provide an excuse for the charge frequently made that he was a charlatan, but when allowance is made for his extraordinary style they reveal his sincerity and receptiveness. They abound in strange words, but the terminology of contemporary medicine was far from perfect or adequate. They contain much which is superstitious, and material concerned with magic, charms and amulets, which is not really a new feature but a sediment from long-established medical practice. There is little of scientific interest, apart from a few vague remarks on mining and metallurgy and a mention of zinc, all of which is miner's gossip. There is much hinting at wonderful new chemical remedies, but no intelligible accounts of experiments by which they were discovered or processes by which they were prepared. There is no indication that Paracelsus did make any experiments in chemistry on scientific lines, although tradition, some of it good, suggests that he did. The views that the chemical information in the works attributed to Basil Valentine is due to Paracelsus, and that some of the important views found in the writings of Van Helmont are really his, will not bear close examination. His writings contain a great deal of boasting and harsh judgments of the physicians. Some allowance must be made for this. Paracelsus was certainly ahead of most of his plodding contemporaries, and his eager reforming zeal irritated them into malicious attempts to undermine his authority and bring him to contempt. This must have exasperated a man with much less patience and restraint than he possessed, and in circles where so much bitter opposition was met a violent reaction is only to be expected.

Where so few actual scientific contributions can be found it is perhaps a fair estimate of Paracelsus's merit in science to say that he pointed the way along which fruitful progress could be made and showed that nothing can be achieved by reliance on tradition in itself. He gave hints which in the hands of his followers came to fruition. He is regarded as the originator in chemistry of the famous theory of the three "hypostatical" principles, mercury, sulphur and salt, which Boyle said were professed by the "vulgar spagirists" of his time. Of these three, two and the most important, mercury and sulphur, were very much older than Paracelsus's time, although they had not been regarded as so widely distributed as he assumed;

and his salt is such a vague entity that it can scarcely be said to have any value in chemical theory. Still, some link may be traced between this *tria prima* and the three 'earths' of Becher, which led in turn to the phlogiston theory, an important phase in the development of theoretical chemistry.

In calling to memory the death of Paracelsus at Salzburg on September 24, 1541, we can point to little which is definite in his scientific contributions, but his insistence that Nature has little regard for theoretical systems or cherished traditions is essentially scientific and certainly played a part in the progress which was to lead to the "Sceptical Chymist" of Robert Boyle, a work in which Paracelsus is respectfully quoted and criticized. It seems that much of the fame of Paracelsus (like much of the discredit which is attached to his name) rests on popular estimates, and his contributions are not nearly so important as those of men whose names are practically unknown. It is probably certain that but for his emphatic lead the advances in chemistry which followed him so closely would have been deferred, and he well deserves a place in the annals of science quite apart from his contributions to medicine.

P. S. PALLAS (1741-1811)

By Eng.-Captain E. C. Smith, O.B.E., R.N.

ON September 22 occurs the bicentenary of the birth of Peter Simon Pallas, one of the greatest naturalists and scientific explorers of the eighteenth century. Though German by birth, he passed forty-two years in the service of the Russian Government, and the most fruitful part of his life was the six arduous years, 1768–1774, which he spent exploring the eastern parts of European Russia and the plains and mountains of Siberia.

The son of a surgeon, Simon Pallas (1694–1770), he was born in Berlin, and after studying at Halle and Göttingen graduated in medicine at Leyden. He then spent about a year in England examining and studying zoological collections and afterwards at The Hague published his first work on zoology. It was, however, not long before a more active career opened before him. In 1768, at the age of twenty-seven, he accepted the invitation of the Empress Catherine II to occupy a chair of natural history in the Imperial Academy of Sciences, St. Petersburg, and this led almost immediately to his appointment to an expedition being sent out, first to observe the Transit of Venus of 1769, and secondly to gather information about the peoples, plants, animals, climate and geography of the vast dominion of Siberia and of other little-known parts of the Russian Empire.

Scientific expeditions by land and sea under official auspices were a feature of the eighteenth century, and most of these expeditions were fostered by the Royal Society of London, the Paris Academy of Sciences and similar bodies. Among such expeditions was that made during 1733–1743 by Behring, J. G. Gmelin, G. F. Muller, S. Kraschenìnnikof and others for the Russian Government; this added immensely to the knowledge of northern Asia from the Urals to Kamchatka. Two years after this expedition set out the Paris Academy of Sciences sent Bouguer, Godin and La Condamine to Peru to determine the figure of the earth, while others were sent to Lapland. The Transit of Venus of 1761 saw other expeditions. One of these was carried out for the Paris Academy of Sciences by the Abbé Jean Chappe D'Auteroche (1722–69), who observed the transit at Tobolsk, the capital of Siberia. When this astronomer published an account of his travels he made some remarks about the state of Russia which led Catherine, who had literary leanings, to reply in a brochure entitled "Antidote contre le voyage de l'abbé Chappe".

As the 1769 Transit of Venus approached, Catherine determined to arrange expeditions second to none, and the Imperial Academy of Sciences, most of whose leading members were foreigners, was asked to draw up full instructions. Altogether seven astronomers and five naturalists with several assistants were attracted by Catherine's offers. The Swiss astronomers, J. A. Mallet (1740–90) and J. L. Pictet (1739–81), were sent to Lapland; the German scientific worker, W. L. Kraft (1743–1814), to Orenburg; the Russian mathematician and geographer, S. Rumoffski (1734–1815), to the Pola peninsula: and G. M. Lowitz (1722–74) to the Volga district. To the south-west of Russia were also sent the naturalists, S. G. Gmelin (1743–74), nephew of J. G. Gmelin, and J. A. Guldenstaedt (1745–80). Pallas himself left St. Petersburg in June 1768, spending the summer in the Russian plains and wintering at Simbersk on the Volga. He next visited Tartary, examined the shores of the Caspian, and in 1770 crossed the Urals to Catherinenburg. Having examined the mines in the district he went to Tobolsk and in 1771 visited

the Altai mountains. Proceeding north, he reached Krasnojarsk, on the Yenisei, and then turned back to the frontiers of China and so in 1773 to Astrakhan, where he met Gmelin. After visiting the Caucasus, he reached St. Petersburg again in July 1774. Lowitz and Gmelin were not so fortunate, for in that year the former was murdered by rebels and the latter died through illness and imprisonment while still carrying out exploration on the shores of the Caspian.

Partly during the expedition and partly afterwards Pallas published in German his "Voyages in Different Parts of the Russian Empire, 1768–75". "Few explorers", said von Zittel, "have contributed such a vast wealth of geographical, geological, botanical, zoological and ethnological observations as Pallas has done in this justly famous work." Another result of his travels was his book on the formation of mountains, his views on this subject giving him a place beside de Saussure as one of the founders of geology.

In 1793, Pallas commenced a journey of two years duration in southern Russia and the Crimea, and liking the district well, in 1795 he settled there on an estate given him by the Empress not long before she died. Here at Simferopol he passed fifteen years, continuing his studies in natural history. In 1810, after the death of his wife, he obtained permission from Alexander I, whose tutor in science he had been, to return home, and he died at Berlin on September 8, 1811, within a few days of his seventieth birthday. Of all the many eminent men of science, such as Delisle, Euler, the Gmelins, Daniel Bernoulli, Lexell, Æpinus, Lehmann, Nicolas Fuss and John Robison, whom succeeding Russian rulers attracted to St. Petersburg, none did greater service for their adopted country than Pallas.

POULTRY AS FOOD CONVERTERS

By E. T. Halnan,
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THE value of the egg as a constituent of wartime dietaries, particularly for children, has to some extent been overshadowed by the insistence placed on milk as a perfect food. In point of fact, milk is not a complete food, being deficient in iron and relatively low in vitamin D, although rich in calcium salts. Eggs, on the other hand, have a poor calcium content, but are rich sources both of vitamin D and iron.

Both products are of high biological value, and are in a sense complementary to one another, mixtures of these two forming a perfect diet for young growing animals. Thus De Sanctis[1] reports the case of a three-months-old infant failing to gain weight on a whole-milk dextrimaltose formula, but responding and giving 8–12 oz. gains weekly when one teaspoon of soft-boiled egg yolk was added daily. Tweddell[2] similarly got satisfactory responses in two infants aged eight and nine months respectively by the inclusion of one raw egg daily in their milk diet. Hess[3], in efforts to combat rickets in babies, used egg yolk with marked effect, and recommends the inclusion of the yolk of a raw egg daily in the milk formula of a three-months-old infant as good routine practice.

The essential point to note in these cases is the failure of milk to prove adequate in the diets of some infants, and the power of egg yolk to correct its inadequacy. Moreover, both eggs and chicken meat are easily digested and readily tolerated by those with weak digestions, consequently they form essential articles in the diets of those recovering from illness. In addition, the hæmoglobin-forming power of eggs in cases of war-wounded patients suffering from loss of blood should not be overlooked.

On dietetic grounds therefore, the maintenance of an adequate egg supply appears to be just as vital to the health of the nation as the maintenance of an adequate milk supply. If, however, the home food production policy of the Government is considered, it would appear that this fact has not hitherto received the consideration that it merits. The shortage of animal feeding-stuffs, particularly concentrates, led the Government shortly after the outbreak of war to assign an order of priority to various classes of farm livestock for such feeding-stuffs as were available. Several factors appear to have influenced the final decision, among which may be named the relative efficiencies of the various classes of livestock as converters of animal feeding-stuffs to human food, the need for maintenance of land fertility, the fact that the foods normally fed to pigs and poultry largely consisted of materials available for direct human use, and the fact that the Scandinavian and the Low Countries were then available as sources of supply for eggs and pig products. As the result of these and

possibly other considerations, the final order of priority was: (1) dairy cows (as milk); (2) sheep and feeding cattle; (3) pigs for meat production and poultry for egg production.

It may be as well to point out that the Government of 1918[4], faced with a similar situation, placed the order of priority as follows: (1) working horses: (2) dairy cows; (3) breeding stock. Some allowances were to be made to pigs and poultry and breeding ewes, but none to fattening sheep or fattening cattle. The present order of priority for feeding-stuffs has caused the false impression to arise that both pigs and poultry are wasteful converters of feeding-stuffs; moreover, statements have appeared in the Press to the effect that this is the considered opinion of men of science. It may, therefore, be as well to consider the available evidence on this point.

At the present time the main problem that appears to be facing Great Britain so far as food supply is concerned is a prospective shortage of food proteins, particularly those of high biological value. The most efficient use of animal feeding-stuff protein for the production of human food protein consequently appears to be called for, and our considerations may therefore be conveniently directed to this issue.

In 1939 I made a careful estimate of the relative efficiencies of the various classes of farm animals as converters of feeding-stuff protein to human food protein. In this estimate, 100 lb. of digestible feeding-stuff protein yielded the following amounts of food protein available for use by humans: (1) dairy cow (as milk, yield 600 gallons a year), 35·8 lb.; (2) hen (as eggs, yield 140 eggs a year), 31·6 lb.; (3) pig (as pork), 21·2 lb.; (4) hen (as meat), 18·0 lb.; (5) bullock (as baby beef), 7·8 lb.; (as Norfolk beef), 5·9 lb.; (as grass beef), 5·4 lb. Owing to the absence of adequate data no estimate of the value of the sheep as a converter of feeding-stuff protein was made; but the opinion was given that, whereas grassland sheep production should be encouraged, arable land sheep should be discouraged, since in the latter case the land required for sheep keep could be better utilized for the production of grain and vegetables for direct human consumption. This memorandum was submitted to the appropriate Government departments and doubtless received due consideration. More recently, Leitch and Godden[5] have presented a report on the point at issue, after consideration of all the available scientific data. Placing their results in order of priority so far as efficiency of conversion of feeding-stuff protein to human food protein is concerned, we get the following results: 100 lb. of protein equivalent yield (1) dairy cow (as milk, yield 2 gallons a day), 35·1 lb.; (2) hen (as eggs, yield 200 eggs a year), 26·4–29·8 lb.; (3) hen (as meat), 21·8–26·3 lb.; (4) pig (as pork), 19·0 lb.; (5) baby beef, 15·5 lb.; (6) sheep (as lamb), 13·2 lb.; (7) fat bullock, 8·7–8·9 lb.

Although arrived at by different methods of computation and from different sources, it is of interest to note that roughly the same order of priority is reached by these authors as by my earlier estimate, and gives confidence in the view that the order of priority so established is in accordance with actual fact.

Regarded strictly, therefore, from the point of view of efficiency of conversion of feeding-stuff protein to human food protein, the hen as an egg producer would appear to rank in order of priority next to the dairy cow, and judged on this ground alone the hen has a better claim to available food supplies than any class of farm animal other than the dairy cow. Moreover, the results obtained indicate that the decision of the Government in 1918 not to allot supplies of feeding-stuffs to fattening sheep or fattening cattle was justified.

[1] De Sanctis, A. G., *Arch. Pediat.*, 39, 104 (1922).
[2] Tweddell, F., *Med. Record*, N.Y., 100, 935 (1921).
[3] Hess, A. F., *J. Amer. Med. Assoc.*, 81, 15 (1923).
[4] "Live Stock Policy of Board of Agriculture and Ministry of Food", *J. Bd. Agric.*, 24, 1177–1180 (1918).
[5] Leitch, I., and Godden, W., Technical Communication No. 14, p. 46, *Imp. Bur. Anim. Nut.* (1941).

OBITUARIES

Sir Shah Mohammad Sulaiman

As chief justice of the High Court at Allahabad for several years and as vice-chancellor of the Aligarh Muslim University over a considerable period, Sir Shah Sulaiman was a well-known public figure in India. During the last few years of his life he held the distinguished position of one of the three judges of the newly established Federal Court at Delhi. The news of his death early this year at the age of fifty-five came as an unpleasant surprise to his many friends and admirers, and elicited numerous well-merited tributes to his personality and career.

Sulaiman studied mathematics and physics at Cambridge, taking Part II of the Mathematics Tripos in 1909. During his subsequent career as a practising barrister and as a judge at Allahabad, he continued to retain a general interest in the progress of physical science. Later in life, the stimulus of contact with the University staffs at Allahabad and Aligarh led him actively to undertake the study of theoretical physics as a subsidiary pursuit.

Sir Shah's high position in public life secured for his writings and lectures on scientific topics the widest publicity in India, as also a sympathetic, though critical, reception from his academic friends and colleagues. His published papers indicate a marked reluctance to accept the ideas of the newer physics as expounded by the leading authorities on the subject. They largely consist of attempts to explain the facts of the newer physics on the basis of classical or semi-classical ideas aided by special hypotheses. It could scarcely be hoped that work on such lines would find general acceptance.

Sir Shah Sulaiman was the recipient of honorary doctorates from the Universities of Allahabad and Aligarh in recognition of his eminent public services and his deep interest in the cause of education and science. C. V. RAMAN.

Mr. W. A. Taylor, O.B.E.

THE death occurred on August 18 at St. Albans at the age of sixty-eight of Mr. W. A. Taylor, a former superintending examiner at the Patent Office.

After spending eight years at the railway works at Crewe, Taylor obtained a Whitworth scholarship and proceeded to the Royal College of Science, from which he entered the Patent Office as an assistant examiner in 1897, at the age of twenty-five. During the earlier part of his career, he dealt with inventions relating to gearing and clutches. In 1915 he was loaned to the Munitions Inventions Department where he was particularly associated with the early development of the tank and with experiments on body armour, including head protection by steel helmets.

Returning to the Patent Office at the end of the War, he was placed in charge of one of the examining divisions in 1925, and from 1927 until his retirement in 1936 was superintending examiner in charge of classification, during which time he made his main contributions to the work of the Office. Under his direction a separate classification division, akin to that existing in the United States Patent Office, was set up, and he was responsible for the amalgamation of the unclassified series of illustrated abridgments, which had appeared weekly in the *Illustrated Official Journal of Patents* from the time of Mr. Chamberlain's Patents Act of 1883, with the classified series which had been published at intervals from 1894 onwards. By this reform, the classified abridgments were issued sheet by sheet in forty group-volumes within a few weeks of acceptance of the specifications instead of after a period of many months. Another important duty undertaken by Taylor was the setting up of machinery for carrying out the extended search for novelty instituted by the Patents Act of 1932 by which United States specifications and other publications were brought into the field of search.

In the difficult and controversial subject of the classification and indexing of the subject-matter of inventions, Taylor was an advocate of the analytical method and favoured the collection of data relating to materials and machine elements of general application.

He took an active interest in the welfare of the staff and was for some years chairman of the Examining Staff Association. Apart from his activities in the Office, he had many interests in the realms of music, education, sport and travel, and his generous nature and human attitude to affairs gave him a wide circle of friends.

Mr. J. Duncan

THE death of John Duncan on July 28 will be regretted by the many engineers, all over the world, who have at some time been his students. He was seventy-two years of age and had for several years suffered severely, although in the end, the acute stage of his illness lasted only a few days.

Duncan went to Hutchinson's Grammar School in Glasgow, his birth-place, and his early training in engineering was received at the works of Messrs. Duncan Stewart & Co., Ltd. He studied at the Royal Technical College, Glasgow, and then in the University of Glasgow. From there he was appointed, in 1896, as lecturer in engineering at University College, Nottingham. In 1898, at the opening of the Municipal Technical Institute at West Ham, now the West Ham Municipal College, he was appointed lecturer in mechanical and civil engineering, and after a short time became head of the Department of Engineering. His organizing ability soon showed itself, for a set of empty rooms quickly became a department excellently equipped both in staff and machinery.

On the reconstitution of the University of London in the early years of the century, Duncan was made a 'recognized teacher' in the University in engineering, being one of the first so appointed. He served on the Board of Studies in Engineering in the University until his retirement from teaching in 1929, and on many occasions was examiner in the subjects of engineering.

Duncan's lectures and practical courses at West Ham were always the admiration of his colleagues, for as well as being thoroughly skilled in practice and draughtsmanship, he had a wide knowledge of theory and always spurred on his students in the mathematical side of their work. His clearness of exposition will always be appreciated where the many text-books that he contrived to write during his busy career are used.

WE regret to announce the following deaths:

Prof. A. G. Green, F.R.S., formerly professor of tinctorial chemistry in the University of Leeds, and director of research to the British Dyestuffs Corporation, on September 12, aged seventy-seven.

Mr. John Still, formerly secretary of the Ceylon Association in London and an authority on the antiquities and natives of Ceylon, on September 9, aged sixty-one.

Dr. Guy Wood, who had been honorary treasurer of the Marine Biological Association of the United Kingdom since 1934, on September 4.

NEWS AND VIEWS

British Association: Science and World Order

FURTHER information is now available concerning the conference on "Science and World Order" to be held under the auspices of the British Association (Division for Social and International Relations of Science) during September 26–28, at the Royal Institution (see p. 331 of this issue).

The First Session, under the chairmanship of Sir Richard Gregory, president of the British Association, will deal with "Science in Government". It will deal with the use of scientific men and scientific methods within departments of Government, and with the development of Government research. Prof. A. V. Hill will describe the use which has been made of scientific workers, and the way in which co-operation and collaboration has been secured in Britain and between Britain and the United States. Prof. J. D. Bernal will deal with the shape of scientific organization within Government service, and its possible future development. A French representative will be asked to deal with the organization of science in France before the War. It is hoped that the Chinese representative will deal with the development and encouragement of scientific organization behind the lines and under stress of war in China, and that a Russian representative will outline the important part which science has played in the development of the U.S.S.R.

The Second Session, under the chairmanship of the United States Ambassador, Mr. Winant, will deal with "Science and Human Needs". Sir John Orr will be dealing with food in terms of the advance in the science of nutrition, of the work which has been done in the form of surveys of food requirements of various countries, of the inadequacies, and of the means, which science offers, of raising the standard of nutrition throughout the world. Sir Harold Hartley, speaking on "Power", will discuss the development of the natural resources of the world to secure the maximum benefit. An American representative will probably deal with the harnessing of power to the new amenities of life.

The Third Session, under the chairmanship of the Russian Ambassador, Mr. Maisky, is concerned with "Science and World Planning". An American representative will deal with large-scale projects, such as the Tennessee Valley development, illustrate the plan behind it, and the future of such development. Prof. Sargant Florence will discuss the redistribution of the population, which has been made possible by electrification, but which, without planning, may equally lead to even greater concentration in conurbations. Other speakers will relate similar examples to the general need for large-scale planning in terms of world reorganization.

The Fourth Session, under the chairmanship of Dr. Benes, President of the Czechoslovak Republic, will deal with "Science and Technological Advance". It will be concerned with the new processes, new materials, and new production techniques, which have been made possible by science and have been accelerated by war, and which, under planning, can mean the release of abundance, and without planning, will mean economic chaos.

The Fifth Session, under the chairmanship of the Chinese Ambassador, Dr. Wellington Koo, will deal with "Science and Post-War Relief". Representative speakers will concern themselves with: (1) the risks of epidemic diseases through war exhaustion, and the measures to counter them; (2) the risks of famine and the distribution of surpluses which are now being accumulated throughout the world; (3) 'scorched earth' problems of soil-rehabilitation. Others will deal with the development of backward and neglected areas.

The Sixth Session, under the chairmanship of Mr. H. G. Wells, will deal with "Science and the World Mind". The major problem is how to make the peoples and nations comprehend the meaning of scientific development and the ways in which these can be used for human betterment and social security. At the end of the conference, the president, Sir Richard Gregory, will put forward a new Charter of Scientific Fellowship.

University of Birmingham: Chair of Zoology

THE appointment of Prof. L. T. Hogben, F.R.S., to the chair of zoology in the University of Birmingham, represents a serious loss to the University of Aberdeen where, in the course of a short but fruitful tenure of the regius chair of natural history, he had built up one of the most attractive and active departments in Great Britain. Both at Aberdeen and Cape Town, Prof. Hogben adapted the policy of his department to fit in with local biological interests and exploited to the fullest extent the natural resources of the neighbourhood. At Birmingham he will find ample scope for similar activity, and his greater proximity to London will enable him to attend meetings from which his absence has, too long, been felt.

Among academic zoologists Prof. Hogben is distinguished for his well-known analysis of the pigmentary effector systems of vertebrates, particularly those of the amphibia; he has also made very important contributions to genetics. In both these fields he has had numerous students in Great Britain and elsewhere. In much wider fields Prof. Hogben is known as the author of "Mathematics for the Million" and "Science for the Citizen". Both of these books show not only a very remarkable width of vision but also a profound belief in the intelligence of the average man. At Birmingham, Prof. Hogben will find a fertile field, well tilled by his predecessor, Prof. H. Munro Fox, F.R.S. (NATURE, June 28, p. 800), and of the abundance of the crop he will reap there can be no doubt.

The Generic Names Fenestella and Fenestrellina

Dr. G. E. Condra and M. K. Elias, of the University of Nebraska, have sent a notification to the Editors of NATURE of a proposal to preserve the generic name Fenestella. The following is an abstract of the document:

The International Commission on Zoological Nomenclature is asked to suspend the Rules of Zoological Nomenclature in the case of *Fenestella* Lonsdale, the well-known genus of late Palæozoic Cryptostomatous Bryozoa, and retain this name as a *nomen conservandum*. The history is as follows: *Fenestella*, Bolten, 1798, for a Lamellibranch Mollusc; synonym of *Anomia* Linnæus, 1758; *Fenestella*, Lonsdale, 1839, for a Cryptostome bryozoan; genotype *F. plebeia* McCoy; *Fenestrellina* d'Orbigny, used by Bassler for the pre-occupied name *Fenestella* Lonsdale. But the genotype of *Fenestrellina* d'Orbigny is *Fenestella crassa* McCoy, which is not congeneric with *Fenestella lebeia* McCoy. Therefore a new name is needed for the genus *Fenestella* Lonsdale *non* Bolten, unless the Rules of Zoological Nomenclature are superseded, and *Fenestella* Lonsdale is conserved. In order to avoid a new name, and because it is in every way desirable to conserve the well-known, wid ly adapted, and long-established Bryozoan genus *Fenestella*, it is asked that the Rules of Zoological Nomenclature be suspended in this instance, and *Fenestella* be kept as a *nomen conservandum* for the Bryozoan genus.

The University of London

THE report of the Principal on the work of the University of London during 1940–41 is distressing testimony to the wanton destructiveness of modern warfare. The wisdom of the policy of dispersal, which at one time aroused criticism, has been fully borne out by the widespread damage that many of the University buildings have sustained from air raids. This damage has already been described in NATURE. The teaching staff of the University has lost the services of eighty-six professors and readers, who together with many other teachers are now engaged in various forms of war work. Owing to the claims of national service the roll of internal students in the second year of war is expected to show a fall of about 40 per cent. Nevertheless, in spite of all difficulties, the essential work of the University has been carried on in a most remarkable manner. Except for certain readjustments necessitated by war conditions, no significant changes have been made in the curriculum, and examination standards have been fully maintained.

The complete range of external examinations was carried through under the scheme of decentralization. In the first year of war, external examinations were held in some forty centres overseas, and more than 1,200 students were examined. Although this operation involved the distribution of very many printed papers, and the collection of some thousands of scripts only two scripts were lost as a result of enemy action. The work of the University for its External Students has been fully maintained, in fact, in certain directions the University has extended its activities. Some hundreds of students now serving in different branches of H.M. Forces have received assistance in continuing their work for degrees. Educational contacts have been established with Allied personnel now in Great Britain, and through the Red Cross even prisoners of war in Germany have been enabled to keep their intellectual interests alive.

Among several benefactions received during the year, the University was given an endowment by the Clothworkers' Company for a William Gilles fellowship for research in science, to the value of £220 for one year, to be awarded biennially. Dr. T. H. Sanderson-Wells has provided funds for the endowment of an occasional Sanderson-Wells Lecture, on human ailments with special reference to soil fertility. Mrs. E. L. Hamilton has presented to the London School of Hygiene and Tropical Medicine £1,500 to be used in the prevention of disease in the tropics. Developments in educational policy and organization are of necessity in abeyance, but in one direction at any rate useful preparatory work has been done, for an influential advisory board has been set up to report on the co-ordination and extension of Colonial studies and researches, for which support may be forthcoming from the Colonial Office as part of the Government plans arranged early in 1940.

Plastic White Lines for Roads

THE majority of the white lines applied to road surfaces for aiding traffic flow are prepared with white paints made from pigmented solutions of Manila resin in alcohol; such paints are the subject of Specification BS/ARP 38. Attention has recently been given to alternative white-line materials by the Paint Research Station and the Road Research Laboratory. According to *Roads and Road Construction* of September, one of the most promising alternatives is a thermo-plastic material applied hot to the road surface as a thin layer which sets hard on cooling. This type of material has the advantage that its set does not depend on evaporation of a volatile constituent; it hardens rapidly, allowing traffic to pass over it within a few minutes of application. It has good wear resistance and maintains a reasonably white colour. Thermoplastic materials of a proprietary type have been subjected to road tests during the past two years and in some instances have given satisfactory results. The composition now described is suitable only for open- and medium-textured road surfaces which provide a certain amount of key or mechanical grip. It may be applied to an existing road surface without insetting. A specification has been drawn up for the manufacture and application of the composition.

During the past year, trials have also been made with a number of compositions based on a light-coloured binder compounded with a white filler and a high proportion of a light-coloured sand or other fine aggregate. The filler is a mixture of equal weights of finely divided silica and the pigment titanium oxide. The binder consists of 80 per cent by weight of rosin, the remainder being crude wool grease. This composition can only be applied during spring and

summer months, in warm, dry weather. The composition is now under test; it is in satisfactory condition after five months on a busy trunk road and after ten months on a by-road, and from the results of these and other tests, a useful average life of at least six months may be expected. The colour, while not so white as that of newly painted white lines conforming to BS/ARP 38, nevertheless gives a good contrast with the road surface when observed during day- and night-driving and does not degenerate appreciably.

Health of Southern Rhodesia

IN his recently published annual report for 1939, Dr. Andrew Paton Martin, medical officer of health for Southern Rhodesia, directs attention to the decrease in the birth-rate, the increase in venereal disease and the infiltration of tuberculosis in the colony. There has been an appreciable decrease in scurvy in the mining natives, but the methods of feeding the employees are still far from satisfactory. Of the tropical diseases prevalent in Southern Rhodesia malaria is the most serious, as it caused 10 per cent of the deaths in 1939. Bilharziasis followed it close, and leprosy is a big problem, but trypanosomiasis seems to be absent.

Earthquake in Turkey

A SERIOUS earthquake with its epicentre near Agri, some 70 miles east of Erserum in Turkey, was reported on September 12. Full details are not yet available, but it is feared that the death roll may amount to 500. It will be remembered that the most severe earthquake ever experienced in Turkey took place on December 27, 1939 (see NATURE, January 6, 1940), in Anatolia, and serious aftershocks have occurred at intervals since that time. It may be that large fault blocks in the area have not yet attained their final position of equilibrium, and that parts of the subcrustal layers may still be under some elastic strain.

Earth Tremor in Scotland

ON September 6 an earth tremor shook the Stirling district in Scotland. Furniture was moved by the shock in the villages of Cambus Barrow and Whins o'Milton, but no damage is reported. Stirling district experienced a previous tremor on the night of February 2–3, 1940 (NATURE, February 10, 1940).

Bequests to the University of Sydney

THE University of Sydney has recently received a bequest of £60,000 from the estate of the late Sir Hugh Denison. This bequest is particularly valuable as it is for general scientific research, and unconditional.

The McGarvie Smith Institute of Sydney has made a grant of £9,000 in addition to earlier grants for the extension of the equipment facilities of the Animal Husbandry Farm which bears its name, and which forms an important part of the equipment of the Faculty of Veterinary Science of the University.

Awards of the Medical Research Council of Ireland

THE Medical Research Council of Ireland has made the following awards during the half-year ended June 30, 1941: *Training grants:* Miss D. A. Kilbride for one year from August 1, 1941, to carry out an investigation of iodine absorption by means of balance experiments; and Miss E. O'Donovan for one year from June 1, 1941, to assist in the investigation of the goitre problem by studying the retention of iodine under varying conditions of diet, the work in both instances to be done in the Department of Chemistry, University College, Cork, under the direction of Prof. J. Reilly and Dr. E. M. Mason; *Whole-time grant:* Dr. Cecil Mushatt for four months from March 1, 1941, to enable him to continue his research work at the Johns Hopkins Hospital; *Grants-in-aid:* Dr. James Deeny for six months from July 1, 1941, to investigate the relationship of vitamin C to the formation of complement and the relationship of both to immunity; Dr. D.K. Malley, to investigate the effects of the cortical hormone on a case of pre-adolescent type of adrenocortical syndrome; and Dr. J. G. Waugh, towards the expenses of his research work on sulphonamide therapy in the School of Physic, Trinity College, Dublin. The following grants have been renewed for one year: Dr. T. E. T. Bradshaw (from March 1, 1941) and Prof. Hans Sachs (from May 1, 1941). Prof. J. B. Gatenby and Dr. R. G. Cross have relinquished their grants.

Announcements

THE medal of the U.S. Society of Chemical Industry has been awarded to Dr. Elmer K. Bolton, chemical director of the E. I. du Pont de Nemours and Company, in recognition of his work in connexion with the development of Neoprene, Nylon and synthetic rubber.

DR. JEROME C. HUNSAKER, head of the department of mechanical engineering in the Massachusetts Institute of Technology, has become co-ordinator of research and development for the U.S. Navy. He will be assisted by a special board, to be composed of representatives of the chief of naval operations and the commanding officers of the Bureaux of Ships, Ordnance, Aeronautics and Yards and Docks.

PROF. WILLIAM F. DURAND, emeritus professor of mechanical engineering at Stanford University, has been appointed a member of the U.S. National Advisory Committee on Aeronautics. He succeeds Dr. Robert E. Doherty, president of the Carnegie Institute of Technology, who resigned his membership on July 3 to become chairman of the Production Planning Board of the Office of Production Management.

THE following appointments have recently been made in the Colonial Service: D. U. Peters, agricultural officer, Northern Rhodesia; H. A. M. Thompson, agricultural officer, Sierra Leone; C. O. Flemmich (assistant conservator of forests, Malaya), conservator of forests, Fiji.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

"The Philosophy of Physical Science"

THE correspondence on this subject provides a most enlightening example of the present transition in scientific philosophy from the view that science is a description of an objective external world to the view that it is a formulation of the relations found between experiences. Thus, to Sir James Jeans[1], taking the older view, light is an objective entity the velocity of which is either finite or infinite, while Sir Arthur Eddington is interested only in the fact that, since our experiences could be correlated equally well or ill by postulating an infinite or an immeasurably large finite velocity, the possibility of the former can be ignored. It is not surprising that, as Sir James rightly complains, Sir Arthur has not answered his objections. They are meaningless in Sir Arthur's philosophy, and he cannot reply in applicable terms.

I have long been convinced that the view which Sir Arthur now accepts is necessary to make sense of modern (or even older) physics, and have ceased to regard the question as a controversial one. Nevertheless I am equally convinced that Sir Arthur has not grasped the true implications of the new conception, and that Sir James's objection, though stated in terms meaningless to Sir Arthur, is both valid and unanswerable. If we can imagine an alternative experience to that which a law requires, then that law is not logically necessary. There is no escape from that, and if the unexpected should happen, we have to decide between giving up the law and denying the experience. There is no question which is the scientific choice.

It is, however, most desirable to locate the fallacy in Sir Arthur's reasoning. His programme for science is as follows: (1) Construct a scheme of pure reason based on a few *a priori* postulates. (2) Make observations and describe them in terms of those postulates. (3) Draw up a table of correspondences between the elements of the rational scheme and the observations: since the scheme is logically coherent, the corresponding observations must then be logically necessary if the original postulates really lie "at the bottom of things". Hence (4) find criteria for determining that the postulates are so basic. Those criteria having been found, the logical necessity of experience is assured.

The fallacy is, I think, that such criteria cannot exist, because, "in our limited view, at the bottom of things" lies not necessary postulates but experience, and experience is not yet complete. Take any "law of Nature" (for example, the law of gravitation). Deduce where Jupiter will be observed at some instant next year, and suppose that, when the time comes, Jupiter is seen elsewhere. If the law is *a priori* inviolable, Sir Arthur's only explanation can be that observations of Jupiter are not the experiences to which it applies. But if there are criteria for establishing the correspondence between law and observation, he is denied this explanation. What, then, is left to him?

Sir Arthur may be right in believing that his "epistemological" method is a short cut to discovery. Many a theory fundamentally unsound has given valuable guidance to knowledge, and it is certainly to be hoped that "structuralism" will do so. But that is trivial compared with its truth or falsity. As Sir James says, if Sir Arthur's theory is right "its consequences are tremendous—to physics, to philosophy and to humanity". No effort can be too great to clear the matter up, and if, as I believe, Sir Arthur is profoundly wrong, no protest can be too strong against an illusion which would destroy the very fundamentals of science and throw us back intellectually (and therefore socially, since ideas determine the state of our social life) into the dark ages.

It may be added that Sir James Jeans is incorrect in saying that the finiteness of the speed of light is an essential part of the theory of relativity. If that speed had been infinite the truth of the theory would never have been doubted; we should not have expected optical experiments to reveal the Earth's speed. The difficulty was to reconcile the null result of the Michelson-Morley experiment with the *finiteness* of the speed of light. But if that speed will not perform the service which Sir James asks of it, it provides us with a very convenient way of contrasting the alternative viewpoints. Sir Arthur Eddington says: "It is *a priori* necessary that the velocity of light is finite; therefore our observations of Jupiter's satellites could have been predicted and could not have been otherwise." Sir James Jeans says: "It is a fact of Nature that the velocity of light is finite; therefore Jupiter's satellites appeared in the positions which Römer explained". The scientific statement I hold to be this: "Jupiter's satellites were observed in certain positions. Therefore, if we attribute the observations to light travelling from the satellites to us, and assume that the satellites move according to Newton's laws, we must assign a finite velocity to that light".

HERBERT DINGLE.

Imperial College,
London, S.W.7.

[1] NATURE, 148, 140, 255 (1941).

MAY I first correct a slip in my last letter? In contrasting the actual and imagined results of the Michelson-Morley experiment, I absentmindedly interchanged them. I should have written, "It is a logical impossibility that the experiment should give other than a null result in the conditions *described*; but . . ."

Prof. Dingle asks us to imagine Jupiter seen away from its predicted place. Is it not simpler to substitute Uranus, for which this experience actually occurred? Adams and Leverrier rejected both of Dingle's alternatives. They neither gave up the law of gravitation nor denied the experience. They inferred that the system *pointed out* to the observer was not the system *described* to the calculator, a planet present in the former being omitted in the latter. Or, in Dingle's phrase, they amended the table of correspondences. His argument seems to me to fail because it assumes that when the unexpected happens only two courses

are open, surprisingly omitting the third course, which is the course a scientist usually follows. When an object gives an unexpected reaction, he does not rail against the laws of Nature; he concludes "Then it cannot be the object I thought it was."

The sources of gravitation (mass, momentum and pressure) are defined in the rational scheme by the tensor $G_{\mu\nu}-\frac{1}{2}g^{\mu\nu}(G-2\lambda)$, and it is an easy mathematical deduction that Einstein's law of gravitation and the laws of motion are necessarily and universally true; a failure of prediction can only mean that some gravitational source has been overlooked. This is non-controversial; but it is only a preliminary to a more disputed question, Would such a law be admitted as a law of physics, without an additional condition implying some special relevance to experience? My answer, which shocks many people, is that I cannot find that modern physics imposes any such condition of relevance on the laws which it accepts as fundamental. If there is a criterion, it should apply to all the fundamental laws. When we consider gravitation alone, a criterion of "simple application" suggests itself. However arbitrary may be the motion of the planets, Einstein's law will give a corresponding distribution of gravitational sources; but the actual sources in the solar system are few and discrete, and this unforeseen simplification makes long-range prediction possible. Ought we not to take cognizance of the fact that the law of gravitation has a much simpler application to experience than the formal theory suggests? I do not think we can; because the other fundamental laws have not this simple relation to experience. If we want a simple application of them, the experimenter must set his wits to work to create the necessary conditions. We can scarcely accept a criterion of fundamentality which is a function of the technical skill of the experimenter.

The widespread impression that the accepted laws are peculiarly fitted to actual features of experience is, I think, due to too much stress being laid on the historical development of science. Naturally the great advances are made when we find or contrive to create exceptionally simple conditions, so that disentanglement becomes relatively easy; thus the laws become historically associated with an artificial simplicity of experience which is by no means typical. Properly to understand the law of gravitation, we must forget the lucky circumstances of dynamical astronomy which probably accelerated its discovery by hundreds of years, and suppose that it has, for example, been patiently sorted out from an analysis of earthquake waves. In rejecting the criterion of simple application we must reject also the criterion of utility, which is evidently closely connected.

Another objection is that gravitational sources generally betray themselves by emitting or reflecting radiation; so that if Einstein's law indicates a source which we cannot find by radiation tests, something has probably gone wrong. But the finding of such a contradiction presupposes that we are treating gravitation and radiation disconnectedly. In unified theory the scheme of fundamental laws forms an interdependent whole, and we can only recognize agreement or disagreement (correct or incorrect correspondences) with the set of laws as a whole. The congruence of gravitational and radiative sources forms a difficult and technical part of the problem of unification; and it was not until I felt that I had cleared up the physical questions involved that I reached in my own mind the view under discussion.

I think then that the only necessary condition is that the fundamental laws shall form a single scheme, applicable to experience in the sense that all varieties of knowledge gathered by the methods of physical science can be formulated in terms of it. The choice is not limited by considerations of simplicity of application, utility, or appropriateness to the actual state of the universe, and is therefore left open to be determined by the *a priori* considerations described in my last letter. Dingle defends my view (up to a point) as "necessary to make sense of modern . . . physics". That expresses precisely the limits of what I am trying to do—not to make sense of experience, but to make sense of the assertions of modern physics. And the sense which I make of one set of assertions is that they are not assertions about experience at all. The continuation of Dingle's argument is obscure to me because I am unable to ascertain his orientation. In my "frame of reference" experience is at the top, and the physicist has been working his way down to so-called fundamental concepts at the bottom. Dingle upsets my frame by bluntly saying that experience is "in our limited view, at the bottom of things"; what is at the top of things is not stated.

A. S. EDDINGTON.

The Observatory,
Cambridge.

"The Relations between Science and Ethics"

I WOULD like to make a reply to some of the very interesting comments on my article[1] on the relations of science and ethics. I will try to be brief although some of the questions raised are probably due to the brevity of the original discussion. I will not allude to all the points of agreement, which are actually more numerous than some of the writers suggested. Thus I entirely agree with Dr. Matthews that ideas affect societies; in fact I supported this point by a quotation from Engels.

There are two major issues: whether ethical principles are founded on our experience, and the problem of free will. In the former connexion the arguments of my opponents have been stated by Prof. Joad in a form which is so nearly a *reductio ad absurdum* that much of my work has been done for me. "I cannot understand", he writes, "how anything can be measured without a ruler which is external to and other than what it measures." By this he certainly does not mean merely that no system of mensuration is possible with less than two objects; for after all I am not suggesting that an ethical system involving different degrees of good would be engendered by a universe consisting of a single indivisible act. Nor, I presume, does he refer to the fact that our units of measurement, though roughly specified by the nature of the world, are in detail defined arbitrarily. His remark only provides a basis for his subsequent argument if it is taken to mean that we determine the relative sizes of objects by reference to some transcendental foot-rule reached down from beyond the boundaries of space and time. This, as we know from the theory of relativity, is untrue. The space–time framework is a function of the material objects lying within it. I might indeed have expressed my main contention by saying that, just as space–time issues from the material world, so the ethical system could be logically derived from our experiences. I may assure the Dean of St. Paul's that I am not urging that we should immediately

reject all ethical principles which we cannot in practice trace back to biological and sociological data, any more than I suggest that we should all learn enough mathematics to convince Sir Arthur Eddington that we fully understand the logical structure of an inch. I am merely concerned to show that the validity of ethical principles can be accepted even if we reject any criterion imported from outside the perceptual universe.

Joad again reduces to absurdity the view that there is an ethical criterion independent of experience by his statement that we all know (innately is implied by his argument) that "we ought to live very much as Christ enjoined". There are a thousand localities, from Dachau to Dahomey, where it is impossible to assert this with any plausibility. We prefer the ethical intuitions of Christ, Buddha or Socrates to those of Hitler or Rosenberg not because they are more mystical but because they seem more likely to carry society forward in the direction it has already taken. I see no grounds for rejecting the view which I put forward on the basis of psychological and anthropological evidence, that our tendencies towards sympathetic behaviour, although of sufficient strength to have enabled man to develop a degree of social existence, are nevertheless merely one of the general drives towards various unspecific forms of behaviour by which his conduct is affected.

The argument given above must serve, in the space available, as a reply to Prof. de Burgh, who demands an unconditional validity for my example of an ethical scientific statement, but is apparently willing to forgo it for the contrasted 'Thou shalt not kill', the ethical nature of which he would not deny.

The widespread disagreement with my argument about evolution is a continuation of the same dispute. In the first place, I am glad to find that the course of evolution has been revealed, not only to myself and Herbert Spencer, as Prof. Ritchie suggested, but also to Prof. Huxley; surely the attempt to repudiate the normally accepted evolutionary sequence on the grounds that certain primitive animals still exist is a forlorn crusade. But the crux is my statement that the direction of evolution is good simply because it *is* good. By that I meant that if the ethical system is to be derived from the nature of the experiential world, we must pay attention to what that world is like; and one of the most important data is the scientifically ascertained course of evolution. The remark about fatalism which followed was intended to indicate that the general trend may suffer temporary set-backs. Just as loss of structure due to parasitism, as in Sacculina, does occur but is not typical of the greater part of evolutionary change, so social regressions, of a spatially or temporarily limited nature, are easily conceivable. This point was expanded by Prof. Huxley, with whose remarks both here and in his valuable essay "The Uniqueness of Man" I am in substantial agreement.

Prof. Stebbing attacks an outlying bastion of my position in this field; not my actual discussion of evolution so much as my comments on T. H. Huxley's remarks about it. My "three different answers" to Huxley's argument were answers to three different questions. The first was a rejection of his description of its *methods*, the second of its *results*. In the third I countered the possible objection that, logical though my derivation of the good might at first sight appear to be, I had actually identified it with something which no one had ever dreamed of calling by that name. I was arguing that my conception was not only self-consistent but also not unrelated to the conventional meaning of "good".

A more difficult point is raised by those who suggest the possibility of a general and persistent regression, for example, by the operation of the classical second law of thermodynamics. I think that the difficulty, if it should at any future time actually arise, could only be got over by a theory of levels of ethics. One could distinguish a social good, dependent on a good derived from human individual biology, which again would be dependent on the effective principles of change in the physico-chemical world; and one would have to be content to deduce that a continual increase in physical good gives rise to an undulation in the development of biological good. But difficult though the problem undoubtedly is, that difficulty does not arise only on my theory of ethics; how can it be surmounted if ethical values are attributed to a beneficent deity?

The other fundamental disagreement, which relates to the problem of free will, was raised explicitly by the Dean of St. Paul's and Prof. de Burgh, and implicitly by several others. I confess myself unable to offer a satisfactory reconciliation of materialistic determinism and the efficacy of the human will; but again the problem is not one for my theory alone, and I shall be agreeably surprised if my commentators are in a much more comfortable logical position. I can only make one suggestion, with the greatest tentativeness. First, I suggest that it may be more profitable, in discussing this matter, to picture the human mind not as a simple mechanism of stimulus and response, but as containing a set of drives (each, figuratively speaking, a complicated motor) one or other of which can be set in motion by pressing the appropriate switch. In the decision whether, say, the sex or the nutritive drive becomes activated, the external stimuli not only reach directly for the switches, but also bring into play internal systems whose functions are also to affect the choice of which drive is selected. It may be that the sensation of an effort of will is no more than the conscious symptom of the activity of one of these internal systems, perhaps the super-ego or some part of it. If this part of the mind is, owing to the way in which it has been derived from the external world, normally effective in the direction taken by the evolutionary process as a whole, then could it not be argued that its conscious correlate is in fact indicative of a good impulse, quite independently of whether strict causation is violated or not? The peristaltic action of our bowels, although not under much conscious control, is good on my definition; may not the sensation of a deed well done be just as valid, on a higher plane, as the sensation of physical well-being after exercise and a bath?

Christ's College,
Cambridge.
Sept. 9.
C. H. WADDINGTON.

[1] NATURE, 148, 270 (1941).

DR. WADDINGTON's interesting essay which was published in NATURE of September 6, p. 270, suggests that he is still wavering between the theory that when you have explained a thing you have explained it away, and the fundamental but usually unspoken postulate of science that everything has an explanation, even though this implies an infinite series of causation. In Dr. Waddington's opinion, Marxists

say that ethical systems are epiphenomena which may be left out of account when we are considering the mechanism of social development. T. H. Huxley invented the word 'epiphenomenon' to mean a mental event caused by physical events, but not in its turn causing physical events. I believe that in the long run science has no room for such loose ends. Certainly Marxism has not. "It would be totally absurd", wrote Lenin in "Materialism and Empirio-criticism", "that materialism should maintain the 'lesser' reality of consciousness." Marxists hold that mind is real, but secondary to matter because matter existed before mind. Similarly, they think that economic and social structure largely determines the ethical system. "Thou shalt not commit adultery" is meaningless in a society with no marriage. "Thou shalt not steal" is replaced by "Thou shalt not waste" as property becomes socialized.

Given such a point of view, ethics must be fitted into our world picture, though we cannot yet see how in full detail. It is clear that ethical practices and ideas have a history, both in the development of communities and of individuals. Marxists have stressed the former process, Freudians the latter. This fact does not mean that ethics are arbitrary or baseless. England is real enough though it was once under the sea; vision is real though human embryos have no eyes. It does mean that we cannot act as rightly as possible without a study of contemporary history, which shows us what is alive and growing and what is vestigial in current ethical systems. Perhaps the careful attempts to isolate university staffs from the impact of history, if they have been advantageous to abstract speculation, have disqualified them from valid judgments on the highly concrete problems of right and wrong. The technique of modern warfare, which has broken down this isolation, may lead them to more realistic thinking on ethics.

A fuller study of the literature of Marxism might, I think, not only have shown Dr. Waddington that Engels stressed the importance of unconscious motivation before Freud, but also have made him more sympathetic to T. H. Huxley's thesis in "Evolution and Ethics". Stated in dialectical terms, it is that the cosmic process, which was responsible for human evolution, negates itself by generating the ethical process. The problem then arises of how man is to continue evolving if the congenitally weak are not killed off. Hitler's solution is substantially to abolish ethics. The correct solution will not be so simple. There is a real contradiction, which will be resolved when men not only realize, as eugenists do, that they ought to control their own evolution, but also possess, as they do not at present, the knowledge and technique necessary for this control.

J. B. S. HALDANE.

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Harpenden, Herts.

THE nine contributions to NATURE of September 6 on science and ethics seem to show by their extreme diversity how far thinking men may still be from an understanding of the scope and method of science.

Science is concerned with what a man (or a thing) must do, ethics with what he thinks he should do. Until the contrary is proved, therefore, we must suppose ethics to be derivable from science. How it is to be derived is a question on which scientific men cannot yet be expected to agree. But its historical relationship with the subject-matter of science, with the material conditions of society, is surely a commonplace. The one undergoes evolution, so does the other; and by evolution we mean the irreversible succession of changes which seem to be characteristic of all integrated systems. Take the Christian ethic. It has suffered three major recensions on its journey from the Sea of Galilee to the City of London, each of them well suited to the social and political conditions in which it has in fact proved fit to survive. Meanwhile other systems have arisen outside our own by revolution, and proceeded afterwards by an evolution faster than any we have known. As Prof. Julian Huxley has suggested, some of these systems may have sacrificed the credit of permanent adaptability for the cash of immediate advantage. That is a question which events are now deciding. In doing so these events have already displayed the somewhat Hobbesian principle which would be too obvious to repeat if it were not so often avoided, namely, that individuals will serve the State in proportion as they believe that the State will serve them. This is true at any given moment with little regard to whether that State's government is inherited, elected, or imposed, or all three together.

How the State is to serve the individual most efficiently will therefore depend, under rapidly changing conditions, on the adaptability even more of its ethical than of its political system; and our conditions are changing very rapidly. Evolution is no longer a hypothesis. It is happening on our doorstep. Now in all evolution there is a lag in the adaptation of one part of the organism to changes in another. The more extensive and more highly integrated the organism, the greater the lag. Our society is both extensive and highly integrated, and even the horrors of the industrial revolution in the North scarcely disturbed an ethical system emanating from the comfortable South. Now, however, the situation is different. We are faced, as before, with changing internal conditions. But our system is also in conflict with a second divergent system and at the same time in combination with a third, equally divergent.

It might be supposed that such a crisis is more likely to be resolved by empirical action than by analytical thought. That would be a mistake. Already during the present War political expediency has led to violent changes in the relations of the individual to society, changes which scientific method could have directed long ago and without any such compulsion. Why then should we not prepare for any worse emergencies by applying scientific method before they arise?

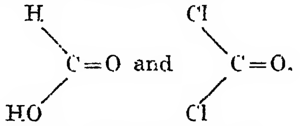
It may be objected that these questions for which a scientific solution is offered are not ethical but political. On the contrary, they are both ethical and political: the distinction lapses as soon as both are subjected to scientific treatment. What a man must do and what a man should do are always the same for the man himself at the moment he does it. In such measure as men submit to scientific discipline that sameness becomes extensible to the whole commonwealth. For universal agreement at successive levels of analysis is not merely the aim of science. It is an aim which experience shows has always been attained.

Science is therefore bound to be the foundation of the ethics of the future and of a system of ethics with some expectation of that universality which has hitherto failed mankind.

C. D. DARLINGTON.
John Innes Horticultural Institution,
London, S.W.19.

The Carbonyls

IN his recent Liversidge Lecture[1], Prof. Sidgwick has referred to the carbonyls as a "very peculiar group", but I would suggest that this is another problem which may well be approached through the medium of organic chemistry[2]. Thus we find that the capacity of a singly bound carbon atom for triple union with another atom does not extend beyond carbon and nitrogen to oxygen. Moreover, when carbon monoxide accordingly yields



the *two* new bonds are formed, in one case by acceptance, and in the other by a donation, of electrons on the part of the carbon atom. It must then be regarded as significant that those metals or ions which are actually able to participate in carbonyl formation are also usually, by reason of an incomplete inner electronic shell, equipped to fulfil this double function, and that in nickel carbonyl the nickel-carbon bonds are found to have a large amount of *double* bond character[3]. Further, it is presumably the result of the donor function of the central atom "that in nearly all the carbonyl compounds the effective atomic number of the central atom adds up to that of an inert gas"[4].

J. KENNER.
College of Technology,
Manchester.
Aug. 27.

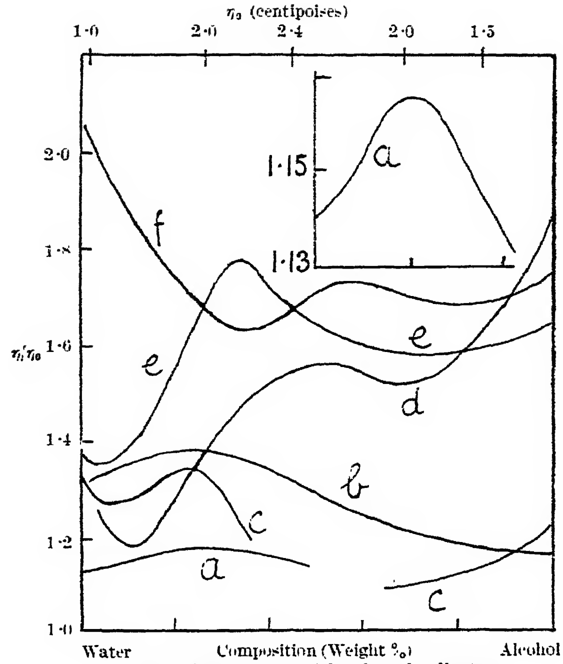
[1] *J. Chem. Soc.*, 438 (1941).
[2] Kenner, NATURE, 147, 482 (1941).
[3] Brockway and Cross, *J. Chem. Phys.*, 3, 828 (1935).
[4] Sidgwick, *loc. cit.*; Sidgwick and Bailey, *Proc. Roy. Soc.*, A, 144, 521 (1934).

Viscosity of Suspensions and Solutions

IT was pointed out earlier[1] that the ratio η/η_0, where η is the viscosity of a suspension of finely divided solid particles in a liquid of viscosity η_0, is variable with η_0, being smaller for liquids of lower viscosity. The explanation in brief appears to be that during flow the solid particles become orientated more quickly in a thinner liquid, so causing less eddying by lying less across the stream of flow.

It is of interest to know that the same viscosity behaviour has been found both with solutions of colloids and crystalloids; if the above explanation holds good, then solvated ions are asymmetric, and during the flow of salt solutions and colloidal dispersions the particles become orientated.

When water and ethyl alcohol are mixed, there is an increase in viscosity reaching a maximum in the neighbourhood of 45 per cent by weight of ethyl alcohol, and it will be seen from the figure that the ratio η/η_0 for (*a*) sodium chloride, 10 gm./100 ml., (*b*) aluminium chloride[2], (*c*) potassium oleate[3], (*d*)



Insert shows curve *a* with enlarged ordinates.

tannic acid[4], (*e*) kaolin,[5] and (*f*) mica[5] dispersed in the binary mixture, increases with increase of η_0, the position of the maximum being affected by the dispersion changes.

E. W. J. MARDLES.
Chemistry Dept.,
Royal Aircraft Establishment,
Farnborough, Hants.

[1] NATURE, 145, 970 (1940); *Trans. Far. Soc.*, 36, 1007 (1940).
[2] Dolian and Briscoe, *J. Phys. Chem.* 41, 1129 (1937).
[3] Bircumshaw, *J. Chem. Soc.*, 123, 91 (1923).
[4] Mardles, *J. Chem. Soc.*, 125, 2244 (1924).
[5] Mardles, *Trans. Far. Soc.*, 36, 1189 (1940).

Nomenclature of Pituitary Principles

I AGREE with Dr. F. W. Landgrebe[1] that the suffix *trophic* is inappropriate in application to all the known pituitary principles, but I cannot accept the argument that the hitherto accepted suffix *tropic* is unsatisfactory. It is true that τρέπω means *turn*, but the meanings *direct* or *change* also exist and provide a satisfactory basis for the use of the suffix *tropic* as descriptive of those pituitary principles which control or change other tissues or glands. The multiplication of names in a field in which the terminology is already plethoric is bound to lead to confusion, and I would urge that we retain the original suffix *tropic* as a general one to denote those pituitary substances which influence or change other tissues, irrespective of their mode of action. The growth of our knowledge of the nature and action of these substances will no doubt necessitate terminological reclassification, but perhaps in the future, as well as at the present time, the suffix *tropic* may be retained as a general one denoting those hypophyseal principles which influence, in a general manner, other glands and tissues.

F. G. YOUNG.
National Institute for Medical Research,
Hampstead, N.W. 3.
Aug. 7.

[1] NATURE, 148, 85 (1941).

PERSONALITY FACTORS AND PREFERENCE JUDGMENTS

By Dr. H. J. Eysenck,
University College, London

In a previous paper, certain correlations were reported between the temperamental characteristics of a number of observers and their scores on a test of æsthetic appreciation, the K test.[1] As these correlations were based on a comparatively small number of cases, and as the temperament test used was not quite in line with recent developments, the experiment was repeated with certain modifications.

Preference Test. The form of the K test used consisted of fifteen pairs of pictures (twelve pairs of landscapes, and three pairs of portraits) chosen in such a way that the two pictures forming each pair dealt with much the same subject, but in two diffierent ways. One treated the subject in the modern, colourful way associated with Cezanne, van Gogh and Modigliani, the other in the more academic manner of Hobbema, Constable and Wilson. The test is scored in terms of preference for the modern school.

Temperament Test. The Nebraska Personality Inventory was used in this investigation. This test was constructed by Guilford on the basis of his work on personality factors S, E and M[2]. For reasons which will become apparent later, it was decided not to use Guilford's scoring key, but rather to derive a scoring key from a re-analysis of the original correlations on which Guilford's personality factors are based. (I am very much indebted to Prof. Guilford for his kindness in sending me his original data and other material, without which such an analysis would not have been possible.)

Observers. The observers taking part were university students, W.E.A. students, and 'middle-class' people unconnected with academic life. Their ages ranged from seventeen to around fifty; sexes were distributed roughly equally. (I want to record my gratitude to Dr. P. E. Vernon, who very kindly gave the tests to a number of Scottish students.)

Results. Most modern workers seem to regard some such general dichotomy as introversion–extraversion as definitely established in the temperamental field. Guilford's analyses, which revealed no trace of such a general factor, were therefore received with some surprise. It would appear that the explanation of the absence of a general factor of this kind lies in the method of analysis he adopted; by using Thurstone's principle of rotation even a very strong general factor is invariably obliterated. In fact, the situation seems to be exactly parallel to that which prevails in the analysis of cognitive tests, where also the existence of a general factor is disputed by the adherents of Prof. Thurstone.

In the field of cognition it has been shown that the use of Prof. Burt's group-factor method makes it possible to arrive at a compromise between the claims of the 'general factorists' and the 'group factorists'[3]; this method enables us to assess quantitatively the relative importance of these various factors. It appeared reasonable to expect that an application of this method to the data collected by Guilford would lead to a similar compromise between those who claimed to have proved the existence of a general factor of introversion–extraversion, and those who favoured analysis into group-factors only. When an analysis by means of Burt's formula was carried out, a comparatively strong general factor appeared which accounted for 9·5 per cent of the variance and could easily be identified with introversion–extraversion; in addition, three group factors were extracted which accounted for 3·9, 6·4, and 3·5 per cent of the variance respectively. These group factors resembled closely Guilford's personality factors S, E and M.

(A similar result appeared when another research of Guilford's was re-analysed[4]. Here, because of a great deal of overlap, Burt's group-factor method did not seem applicable, and his general-factor method was used. A general introversion–extraversion factor was found to account for 14·8 per cent of the variance, while two other factors accounted for 8·7 per cent and 5·5 per cent respectively. The first of these factors opposed traits characteristic of *depression* and of what Guilford calls *rathymia*; the second factor opposed traits concerned with *thinking* and traits concerned with *feeling*.)

The correlation between the K test and extraversion, as tested by those items in the Nebraska Inventory for which scores could be derived from our analysis, was highly significant, being more than five times its probable error. For fifty observers it was $0·43 \pm 0·08$. This confirms the results reported earlier.

Only one of the correlations between the K test and the three group factors S, E, and M even approaches significance (according to Fisher's test of significance for small samples, a correlation of 0·27 would be significant). These correlations are: K and $S = -0·26$; K and $E = -0·05$; and K and $M = 0·08$.

The observers were asked whether they were conservative or radical politically; it was found that radicalism correlated with the K test to the extent of $0·34 \pm 0·08$, which is definitely significant, and also supports a previous finding[1].

One further point may be worth noting. Dr. P. E. Vernon, who had quite independently found evidence for a factor of the kind described earlier[1] found that those observers who had 'good taste' in painting tended to prefer the modern works, while the others tended to prefer the older artists. The observers in this experiment were asked if they were very much interested in art, interested in art, or not at all interested in art. The average scores of these three groups in the K test were respectively 8·8, 5·9, and 4·0, thus indicating that those who were very much interested in art tended to prefer modern art, and that lesser degrees of interest in art were accompanied by less liking for modern art. It cannot be maintained, of course, that those who say that they are very much interested in art are *eo ipso* those who have good taste, but so far as we can deduce anything at all from these results, they would seem to bear out Dr. Vernon's observation.

Conclusions. It has been confirmed that the K test correlates positively with extraversion and with radicalism. No significant correlations were found with personality factors S, E or M, although a negative correlation with S approached significance. Preference for modern art tended to be associated with general interest in art.

[1] Eysenck, H. J., *Brit. J. Psychol.*, 31, 262 (1941).
[2] Guilford, J. P., and Guilford, R. B., *J. Psychol.*, 2, 109 (1936).
[3] Eysenck, H. J., *Brit. J. Educ. Psychol.*, 9, 270 (1939).
[4] Guilford, J. P., and Guilford, R. B., *J. Abn. Soc. Psychol.*, 34, 21–36 (1939).

RADIO TECHNIQUE IN SURGERY

ALTERNATING currents of radio frequency, while used very largely for radio communication, broadcasting and navigation, also find extensive application nowadays in the hands of the physician and surgeon. Diathermy treatment by means of high-frequency currents has long been practised by the medical profession, but, more recently, other applications of radio technique have been developed. Two of these applications are referred to in considerable detail in the September issue of the *Wireless World*.

The first is described in an illustrated article by A. W. Lay entitled "Electrosurgery", and deals with the use of a high-frequency arc for surgical operations. In such an operation the high-frequency current passes between a specially shaped electrode held by the surgeon, and the patient, who is efficiently earthed by means of an electrode of large area applied in close contact to a smooth part of the body. The cutting effect depends upon the intense concentration of heat in a minute arc, which is struck and maintained at a point of the operating electrode during the course of the cutting stroke, which is controlled by the surgeon. An important feature of the use of this method is that raising the temperature of the blood to about 40° C. accelerates its coagulation and so checks bleeding. A high degree of skill is necessary on the part of the surgeon, as the active electrode must not be allowed to dwell at any point in the course of the cut; otherwise the resultant clotting is too deep, the tissue becomes charred and healing will not follow or will be seriously delayed. Should the electrode unavoidably sever a large blood-vessel, this may be closed by a pair of special forceps, through which a more intense current may then be passed to stop the bleeding.

The high-frequency energy required for cutting operations in general surgery varies from about 30 to 80 watts, and the critical cutting voltage is in the range 220–230 volts R.M.S. At voltages above 250 the arc is too fierce and then there is a tendency for the divided tissue to become charred, which, as already mentioned, must be avoided. Further research is needed to determine the exact process by which the heat disintegrates the molecular structure of the tissue; but if current of suitable value and character is applied, a very clean cut is obtained and the healing compares very well with the effects following the use of the surgeon's knife.

The second reference in the journal mentioned above, is a note referring to a communication in the *Lancet*, describing a radio-frequency probe for locating metallic particles, such as bullets and shell-splinters, in the human body, an instrument of obviously great utility at the present time. A low-power radio frequency oscillator has a tuning coil fitted into a sterilizable porcelain probe, 10 cm. long and 1 cm. diameter. If this coil approaches a metallic substance, such as a splinter, in the area of application, the inductance of the coil, and so the frequency of the oscillator, will change. This frequency change is detected audibly by means of a second reference oscillator, and a detector, amplifier and loud-speaker combination. The apparatus is in general equally sensitive to all metals, and can detect quite small particles, but naturally all metal instruments within a certain radius must be removed while the probe is in use.

The same application of radio frequency currents has been used previously for detecting nails in timber and for other similar purposes, where the location of metallic particles embedded in insulating material is required.

POSTGLACIAL UPLIFT AND THE MOBILITY OF THE EARTH'S INTERIOR

B. GUTENBERG of the Pasadena Seismological Observatory, California, has recently completed a study of the above problem ("Changes in Sea Level, Postglacial Uplift, and Mobility of the Earth's Interior", by Beno Gutenberg, *Bull. Geol. Soc. Amer.*, **52**, 721–72; May 1, 1941). The author has examined carefully the records of tide gauges throughout the world, and finds that these indicate that sea-level generally is rising at an average rate of about 10 cm. a century. In particular, maps have been constructed to show the rate of uplift in Fennoscandia and North America. A discussion of the new material and historic evidence appears to indicate that the uplift is a consequence of isostatic readjustment of the equilibrium disturbed by the postglacial melting of the ice. The remaining uplift is about 200 m. in Fennoscandia and possibly more in North America, where the present rate of uplift has its maximum of about 2 m. per century in the region of Hudson Bay. Simultaneously with the glaciation in Fennoscandia, the British Isles were covered by ice with a centre in the Hebrides where the postglacial uplift exceeded 30 m., decreasing towards Scotland; the zero isobase for the recent millennia intersects northern Ireland and northern England. There is some indication that the zero isobase at present lies south and west of Great Britain. Originally, the time needed to reduce the defect in mass to one half under the regions of uplift was less than 10,000 years, but it has been increasing with time and now exceeds 20,000 years.

Theoretical investigations on the plastic flow in the interior of the earth connected with the uplift have been critically discussed and extended by the author. According to Gutenberg, the movements affect the whole interior of the earth below the regions of uplift; their amplitudes decreasing slowly in the upper 1,000 km. If one assumes a strong lithosphere with a thickness of about 70 km., and below that the asthenosphere with a viscosity of the order of 10^{22} poises, and but little or no strength to prohibit plastic flow, there is no disagreement with observations related to isostasy or deep-focus earthquakes. Tectonic processes connected with isostatic anomalies larger than those in the regions of postglacial uplift are judged to be connected with plastic flow at least down to the core. Gutenberg suggests that defects of mass producing only relatively small gravity

anomalies are able to produce plastic flow if sufficient time is available. The lower limit, below which the processes stop, is important. The *Polfluchtkraft* probably produces stresses of the order of one hundredth of the stresses in Scandinavia stated to be large enough to maintain plastic flow. If the *Polfluchtkraft* is large enough to maintain plastic flow, then we should not be surprised to see continents being shifted by subcrustal flow during the history of the earth under the action of such small *but persistent* forces.

RESEARCH IN GEOPHYSICS

THE annual report of the director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, published in December 1940, is an important record of achievement carried out under difficulties caused by war. It describes the initiation of several fresh experimental projects, the continuance of the previous programme of field observations, the reduction of existing data, the organization of and participation in several important congresses, and the publication of a large number of scientific papers.

With the aid of a cascade high-pressure bomb, hydrostatic pressures in excess of 200,000 atmospheres were attained at the Geophysical Laboratory. This apparatus renders possible the investigation of the magnetic properties of materials at pressures comparable with those actually existing in the earth's interior. For a specimen of cadmium-magnesium-iron-spinel under a pressure of 10,000 atmospheres, a shift in the Curie temperature of as much as 5° C. was observed. These measurements necessitated the development of an alternating-current bridge capable of responding to changes in inductance as small as $1/10^{10}$ henry.

One of the outstanding problems in atmospheric electricity arises in connexion with the 'supply current', which in an undetermined manner supplies negative electricity to the earth at a rate of about 1,800 amperes, and so maintains a negative charge on the surface in fair-weather areas. The actual current flowing from air to earth in such areas depends to some extent upon meteorological and other more or less local factors, which have to be taken into account in arriving at a measure of the supply current.

In connexion with the volcanological investigations planned by the Institution, a series of earth resistivity measurements were carried out with the view of determining the thickness of the extensive deposits of volcanic ash occurring in Guatemala. Depths extending to 600 miles were recorded.

Laboratory work in nuclear physics centred around the high-voltage electrostatic generator, which was induced to yield tensions up to 3–6 million volts, and the installation of a 60-in. cyclotron. Measurements were made on the scattering of slow and fast neutrons by collisions with protons, on the resonance scattering of protons by helium nuclei, and on the splitting of the deuterium nucleus into a proton and a neutron by high-energy gamma radiation.

It is proposed to employ the cyclotron, when completed, in connexion with work of a biological and chemical character, utilizing the radioactive isotopes of ordinary elements as tracers for following various reactions. A scheme for the adequate shielding of those operating the cyclotron from the powerful radiations generated by it has been worked out.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

FRIDAY, SEPTEMBER 26

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2 p.m. —Joint Discussion with the Library Association and the Association of Special Libraries and Information Bureaux on "The Preparation of Indexes to Volumes of Periodicals" (Opener: Dr. S. C. Bradford), and "Listing Titles of Periodical Publications" (Opener: Mr. E. Lancaster-Jones).

FRIDAY–SUNDAY, SEPTEMBER 26–28

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at the Royal Institution, Albemarle Street, London, W.1).—Discussion on "Science and World Order".*

FRIDAY, SEPTEMBER 26

Morning Session: "Science in Government" (Chairman: Sir Richard Gregory, Bart., F.R.S.). Afternoon Session: "Science and Human Needs" (Chairman: Hon. J. G. Winant).

SATURDAY, SEPTEMBER 27

Morning Session: "Science and World Planning" (Chairman: Mr. I. M. Maisky). Afternoon Session: "Science and Technological Advance" (Chairman: Dr. E. Benes).

SUNDAY, SEPTEMBER 28

Morning Session: "Science and Post-War Relief" (Chairman: Dr. Wellington Koo). Afternoon Session: "Science and the World Mind" (Chairman: Mr. H. G. Wells).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHARMACEUTICAL SUBJECTS, and a DEMONSTRATOR IN PHARMACEUTICS—The Principal, College of Technology and Commerce, Leicester (September 27).

ASSISTANT LECTURER IN PHARMACEUTICAL CHEMISTRY—The Registrar, University College, Nottingham (September 29).

LECTURER IN ELECTRICAL ENGINEERING AND ALLIED SUBJECTS—The Principal, County Technical College, Worksop, Notts. (September 30).

SENIOR LECTURER (MALE) IN EDUCATION—The Principal, Training College for Teachers, Collegiate Crescent, Sheffield (September 30).

CHIEF INSTRUCTOR with experience as Head of Engineering Branch of Technical Education, a SPECIALIST IN PHYSICS, and TWO SENIOR and TWO JUNIOR LECTURERS who should be Physicists or Specialists in Mechanical Engineering, for the training of Ordnance Mechanical Engineers in India—The Secretary, Military Department, India Office, London, S.W.1 (October 1).

HEADMASTER of Stockport Grammar School—The Clerk to the Governors, Stockport Grammar School, Mile End, Stockport (October 15).

LECTURER IN ENGINEERING SUBJECTS in the Rotherham College of Technology and Art—The Director of Education, Education Offices, Rotherham.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research: Road Research Laboratory. Wartime Road Note No. 1: Recommendations for Tar Carpets and Surface Dressings. Pp. 12. 6*d*. net. Wartime Road Note No. 2: Sources of Naturally-coloured Chippings in Great Britain. Pp. 14. 6*d*. net. (London: H.M. Stationery Office.) [99

Other Countries

Universidad Nacional de La Plata. Publicaciones de la Facultad de Ciencias Fisicomatematicas. No. 137: Cuarta Reunion Anual de Caminos, Vol. 1. Pp. 350. No. 138: Cuarta Reunion Anual de Caminos, Vol. 2. Pp. 300. (La Plata: Universidad Nacional de La Plata.) [278

National Research Council of Canada. Review of Activities for the Year ended March 1940. (N.R.C. No. 976.) Pp. 155. (Ottawa: National Research Council of Canada.) 75 cents. [278

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NATURE

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EDUCATION FOR INTERNATIONAL RECONSTRUCTION

THE present phase of the War seems particularly appropriate for further consideration of the possibilities arising out of the unrest which is growing in the countries of Europe at present under Nazi control. Propaganda is obviously of high importance in this connexion, and the announcement that the Government has appointed a directorate of political warfare to co-ordinate the whole of our foreign propaganda indicates awareness of the urgency of the situation ; the board will include representatives of the Foreign Office, Ministries of Economic Warfare and Information, and the British Council, and the B.B.C. and other bodies will co-operate. Three recent publications referred to below* make valuable contributions to the discussion of the subject.

Prof. Keeton attributes the failure of the attempt at world organization through the League of Nations to the absence of an international public opinion, and points out that to establish the machinery for international organization without such a public opinion would be to court failure a second time. International public opinion, however, does not grow of its own volition. It is primarily an educational process, and it is as a contribution to the formation of such an opinion that Prof. Keeton urges the formation of an international university.

The creation of an international solidarity sufficiently powerful to make international institutions an effective reality involves the use or development of an adequate technique, the abandonment of the indifference to the needs of human association which has been so common in democratic communities in recent years, and the establishment of some forum for the discussion and exposition of the methods to be used in establishing an international order. Developments such as the 'Round Table' discussions of the University of Chicago need to be taken up in Great Britain and widely extended, and an international university would have as one of its main tasks the organization of research into all those problems which arise in the achievement of a world order, and the publication of the results of such investigations.

An even greater task than research would be the teaching, both of the adult communities and of the youth, of those nations which supported the project. This is a task calling for much imagination and creative thinking as well as for careful organization, if we are to avoid the mistakes that have

* The Case for an International University. By Prof. G. W. Keeton. Pp. 40. (London: C. A. Watts and Co., Ltd., 1941.) 6*d*. net.
Offensive against Germany. By Sebastian Swaffner. (Searchlight Books, No. 2.) Pp. 128. (London: Secker and Warburg, 1941.) 2*s*. net.
P E P Broadsheet: The Future of Germany. (London: P E P, 1941.)

devitalized the adult education movement in Great Britain, and to foster the development, not of a hybrid internationalism, but of an ordered nationalism, seeking to establish the place of individual national cultures within the general pattern. Some of the work which has already been carried out in this field by the Committee of Intellectual Co-operation of the League of Nations has pointed the way, and the beginnings of an interchange of students and teachers already existed before the War.

What is now required is that these possibilities should be explored, not in an academic spirit, but with vigour and vision in full realization of the contribution they offer to the very founding of a new order. For that reason this task cannot be dismissed entirely until hostilities cease. The opportunities that lie to our hand must be seized and used as part of a great moral and spiritual offensive.

Although in his earlier book Sebastian Swaffner directed attention to the offensive value of an international academy, which could so easily be established in Great Britain now that there are so many *émigré* scholars in our midst, apart from a reference in Mr. Eden's speech of July 6 there have been few indications that the significance of the existence in London of a miniature Europe is realized. It would indeed be short-sighted policy if, in the recruitment of their services in our war effort, we overlooked these larger possibilities and failed to utilize their learning and skill in a direction which would demonstrate at once the shallowness of the Nazi pretence of a united Germany or Europe, and make so important a contribution to the preparation of a new European order.

In his "Offensive Against Germany", Swaffner says little about his earlier proposal for such an international academy or university. He is concerned primarily with what he terms the moral-psychological strategy of the War, of which so far we have allowed the Nazis the monopoly. Our attention to morale has been largely the defensive one of maintaining that of our own people, rather than the offensive one of breaking down the morale of our enemy. It is Swaffner's analysis of the weaknesses and vulnerability of German morale, of the methods and prospects of attack rather than his own plan of attack, that give value to his book. It is directly complementary to the P E P broadsheet, for the strategy of political warfare as well as the tactics used to attack the enemy's morale must be largely influenced by our view of what solutions of the problem of Germany are possible.

The P E P broadsheet starts with an analysis of the salient features in the current German situation, pointing out that the concentrated drive of the earlier phase of Nazism is becoming dissipated as an inevitable result of the extension of the Nazi campaign from a limited field where the Germans are in a majority to the wider European field in which they are outnumbered by at least four to one. Simultaneously, the clear-cut ideology and sense of mission developed in a closed artificial atmosphere is becoming confused or even inhibited, while the aggressive spirit of indicting an indefensible old order is giving place to a defensive attitude towards an even less defensible New Order. Strategically, these developments have led to immensely extended and increasingly costly and vulnerable lines of communication. Politically, they involve the inclusion within the German system of a majority of inhabitants non-German in sympathy and increasingly anti-Nazi in attitude. The need for absorbing and restarting a vast range of industries built up in competition with German industry throws a strain on the economic system comparable with that which in the administrative sphere has involved a sacrifice of much of the homogeneity and efficiency achieved by the Nazi system.

No violent revolutionary movement within Germany is to be looked for before or even after a military defeat, but the chances are strongly against successful Nazification of the territories occupied by Germany during the last eighteen months. The chances, on the contrary, are strongly in favour of growing spontaneous resistance movements in neighbouring occupied or threatened territories contributing to German defeats through sabotage, passive resistance and ideological means. The broadsheet concludes that development of these movements, rather than any development within Germany, is likely to shape the future social pattern of a defeated Germany, which must draw heavily from outside to replace the shattered influences now temporarily superseded by Nazism.

Visualizing the immediate post-war period, the P E P broadsheet suggests that there should be four stages in Germany as a whole or in any part of it. First the termination of Nazi power either by driving out the armed forces and Gestapo or by their surrender and demobilization. Then come the establishment of emergency military administration by occupying forces, and the prompt creation of as strong a bulwark against disorders and the lawless seizures of territory as conditions may require. The transfer of all civil affairs to a Reconstruction Commission, including American and of other independent members, as well as political, economic and medical branches, follows, and finally the gradual development of appropriate German self-governing bodies and the gradual transfer of power to them.

Disintegration of a defeated Germany is likely to be much more complete in the present war than

in 1918, owing to the destruction of alternative nuclei and to other factors, but there is no reason why we should not let this disintegration run its course. The bulwark for the protection of Europe as a whole should be formed at first exclusively of non-German forces, and the military occupation of Germany is essential as the first stage in a carefully planned and directed re-creation of German institutions as an essential part of European reconstruction. Successful post-war treatment of Germany depends on the reconciliation of two apparently contradictory propositions: the German people can never again be trusted not to abuse their strength by trying to trample on weaker neighbours, and any settlement which discriminates against and refuses to trust the German people contains the seeds of another German war.

The P E P broadsheet concludes accordingly that Europe must be organized so as to divorce national structures from military and industrial power. This organization must be backed by world control of raw materials and communications, with the object not only of facilitating economic expansion, but also of thwarting policies of autarchy and militarism by automatic sanctions. The post-war settlement of Europe should be along the lines of the British Commonwealth rather than a written constitution, and within this framework the extent of a future German State should be decided by the unfettered choice of the peoples to be included in it. Establishment of social and economic opportunity and security is the only practical basis of enduring peace, and the winning of the peace depends on Britain holding the initiative and using it in the long-term interests of the European majority, and in the convergent interests of the United States and the Dominions, whose co-operation would be needed at every point. Behind this policy there must be visible British sea- and air-power, backed by war industries, maintaining stores instantly available to threatened countries on lease-lend principles, and by availability of strategic bases.

It is against this background that the value of the meeting between President Roosevelt and Mr. Churchill and the Charter of the Atlantic which issued from it must be assessed. The manner in which the eight points of the Charter meet the conclusions drawn from the P E P analysis of the German problem justifies the view that the Charter is a political weapon of the first order. The whole circumstances in which the meeting was held dealt such blows to German claims and propaganda that it can well be hailed as the launching of the moral and political offensive for which an important section of opinion in Great Britain has been pressing. If these hopes and expectations are justified, and the Government seizes the opportunities now opening in this field, and by the effort and thought which it devotes, not sporadically but continuously and systematically, to political warfare, we may well find in this meeting and Charter the token that the path to the New Order for which we strive may be shorter and less tortuous than anything which the military, naval or air situation would warrant our believing.

MAN AS A SOCIAL ORGANISM

Human Nature and the Social Order
By E. L. Thorndike. Pp. xx+1020. (New York: The Macmillan Company, 1940.) 18*s*. net.

"WHAT can men do, what do they do, and what do they want to do?"—these are the questions that Prof. Thorndike seeks to answer in a very comprehensive and elaborate treatise. His undertaking is inspired by the belief that man has the possibility of almost complete control of his fate if only he will be guided by science, and that his failures are attributable to ignorance or folly. The main approach is through biological psychology, but all the social sciences are appealed to and utilized in an effort to deal with the human problem as a whole. The relative immaturity of the sciences dealing with man is continually stressed, but it is claimed that they provide a body of facts and principles which are "far above zero knowledge", and that even now they are capable of affording valuable guidance in the shaping of public policy.

The picture that Prof. Thorndike draws of human nature and its possibilities is based on a view of mind reached by him in his well-known and extensive studies of animal and human behaviour. Man is depicted as a bundle of inborn capacities and wants which are gradually organized by the action of the environment. The underlying conception is on the whole mechanistic. Man is a network of connexions between stimuli and responses operating in the service of a group of wants. A structure is built up as the result of the strengthening of connexions through repetition and the experience of satisfaction and annoyance. It is assumed that for every variation in response

there is traceable a variation in the pre-formed structure. The fact that purposes operate is not denied, but this is not held to be incompatible with the postulates of mechanistic science. Purposive action, Thorndike thinks, is action determined by the consequences of the act. But such determination by consequences is made possible by the fact that whenever a goal is reached after striving there is an experience of satisfaction, and this sets up a 'confirming reaction' which has the property of strengthening any modifiable connexion on which it acts.

The account which is given of human capacities makes use of the vast amount of work which has been done on individual differences. In dealing with abilities stress is laid on their specific character. Factorial analysis is not, in Thorndike's view, likely to reveal the ultimate mental elements, but only statistical composites of them. It would seem that the mind must be conceived as an undifferentiated aggregate of innumerable elements, a mass of imperfectly correlated powers. A like insistence on variety, complexity and specificity is to be noted in the account given of human wants. Thorndike will have nothing to do with those who have tried to reduce the wants of mankind to some small number of primary desires, such as for love, security and power.

The wants of man are innumerable, and to discover how far they are rooted in inborn need, and how far they are artificially generated is a matter of the greatest difficulty. Yet he does give a list of primary desires and aversions, and quotes estimates made by juries of psychologists and others of the time and money spent by adults in the United States in satisfying these desires. Thus judged, it appears that about a fourth of the waking hours are devoted to the needs of subsistence and perpetuation, about a third to entertainment, about a tenth to companionship and affection, and an equal amount for the approval of self and others. Only four per cent of the working hours are given to intellectual wants, and about eight per cent to the welfare of others. Security claims only about seven per cent. As judged by the amount of money spent, it would appear that less than a third of the expenditure is allotted to keeping the population alive and able to reproduce itself; the pleasures of the senses take a tenth, the pleasures of the intellect less than half that. The selfish satisfactions take more than a fifth, and more than a third if the satisfactions of love and benevolence are included. The desire for security takes a tenth.

The value of these estimates which are here quoted as an example of the numerous investigations cited in the work will be doubted by many. Apart from the difficulty of classifying the concrete activities of daily life under broad headings like security, benevolence, and the like, the estimate seems to ignore the distinction between things that need to be bought for money and things that money cannot buy. Nevertheless, the case that Prof. Thorndike makes for the assumption that behaviour runs parallel with, and reveals the strength of, desires and aversions is impressive, and his hope that ultimately reliable scales of measurement will be discovered and effectively utilized in the social sciences may be well warranted.

Prof. Thorndike recognizes that in dealing with social policy we need to know not only what men's capacities are and what they actually want, but also what they ought to want and to avoid. The search for a standard of values is, indeed, regarded by him as "the most important job for thinking men" at the present time. He has, however, little faith in philosophical ethics, and makes a powerful plea for a natural science of values. By this he understands a study of the bearing of acts and conditions on the satisfaction of wants, present and future. Its task would be to give an exact enumeration of wants, of the varying weights to be attached to their satisfaction, and an estimate of the probable consequences of acts in the way of satisfaction or annoyance. He realizes, of course, that we cannot simply identify goodness with the satisfaction of wants, since we often disapprove of what we want. Nevertheless, he thinks that all moral and prudential judgments are ultimately "justified by wants". Presumably we should have to distinguish between wise and unwise wants, but it is difficult to gather what constitutes wisdom and the lack of it in this context. If maximum or harmonious satisfaction is the criterion, we must ask whether this is justified on the ground that people actually want such satisfaction or on the ground that they *ought to* want it, and if, with Prof. Thorndike, we lay stress on justice and impartiality in the allocation of satisfactions, is our ground for doing so to be found that men in fact want justice or impartiality or that they ought to want it.

The problem of the relation between what is desired and what ought to be desired is not seriously faced. I suggest that though a natural science of values is both possible and important, such a science will not of itself solve the problems with which philosophical ethics is concerned, and that judgments of value differ from judgments of fact more radically than Prof. Thorndike would allow. It remains that his careful enumeration of the elements of human welfare would probably find a large measure of agreement in democratic societies, and that an examination of social and political institutions in the light of criteria deducible from them would afford valuable guidance in the task of reconstruction. Of special interest is

the account given of the methods that can be used for comparing the welfare of different communities by means of a weighted average score of their status in matters of health, education, recreation and social well-being.

To the application of his fundamental principles Prof. Thorndike devotes the major part of his treatise. He deals in turn with the problems of the family and eugenics, property and economic organization, law and government. In general his recommendations are in harmony with what might perhaps be called liberal individualism, though he is not so anxious to restrict the sphere of governmental activity as some individualists, and throughout he lays less stress on the particular conclusions he reaches than on the importance of scientific guidance and research in all matters of social policy. Somewhat strange is his treatment of the principle of equality. This he interprets literally, forgetting that most defenders of the principle do not mean by it the view that all should be treated alike, but rather that all differences in treatment require justification in terms of differential merit or need. In this sense of proportionate equality, justice cannot be contrasted with equality, but is, as Aristotle showed, based on it. Indeed, the principle of proportionate equality is implicit in Prof. Thorndike's own discussions.

These matters cannot here be further pursued. Something must be said, however, on the adequacy of the general theory of human nature and society which is here adopted as the basis of inquiry. We must ask, to begin with, whether a theory of society can be built up on the basis of a psychology of individual differences. Prof. Thorndike seems to think that the differences between communities resolve themselves ultimately into differences in endowment of the individuals composing them or in the range of distribution. But social structure can scarcely be interpreted in these terms. The social classes within a community, for example, are not in the main determined by differences in individual endowment, and changes from one type of social stratification to another have nothing to do with changes in genetic endowment. Similarly, on the basis of very similar genetic endowment very different social institutions can be built up. A science of society must therefore be largely a study of social forces, that is, of the forces which arise out of the relations between human beings. No amount of knowledge of individual differences will help us to determine the changes that are likely to be produced in a society by a change in the structure of the family or the penal law. Psychology cannot do the work of sociology. The direct study of social change is especially important if a basis is ever to be found for the calculation of the consequences of acts which Prof. Thorndike insists is so important in dealing with values. His approach here seems to me too individualistic, just as his conception of the human mind is too atomistic. Similarly, in his discussion of valuation, he never raises the question which now, above all, confronts all societies, of the relation between the good of individuals and the good of society. No doubt the elements of human welfare which he enumerates inhere in individuals, but may there not also be value in the forms of social life, for example, in certain types of family life or types of community ?

Finally, Prof. Thorndike's account of the nature and role of purpose in human life raises doubts. If purposive behaviour is but a back-stroke of past experience, a reaction confirmed by past experiences of satisfaction and annoyance, we should expect past experience to be far more effective in the shaping of human purposes than in fact it appears to be. Neither the folly nor the grandeur of human endeavour is in keeping with such dominance of the past. Both imply a power of reference to the future which goes beyond the past, and is in a real sense directive and forward moving, whether for good or ill. MORRIS GINSBERG.

THE HOME IN RECONSTRUCTED ENGLAND

Town and Country Planning

A Study of Physical Environment ; the Prelude to Post-War Reconstruction. By Gilbert McAllister and Elizabeth Glen McAllister. Pp. xxxii+176+12 plates. (London: Faber and Faber, Ltd., 1941.) 12*s*. 6*d*. net.

THERE has been a great deal of talk of reconstruction since the German bombers have done so much damage to British towns : the five years plan for slum clearance which had been embarked upon before the War, the tentative efforts at central re-planning (of which the Bressey Report for London was an example), the recommendations of the Royal Commission on the Location of Industry—these and other similar projects were given a sudden possibility of rapid realization, through the barbarous results of destruction. Instead of the cautious, considerate, hesitating way in which we have so far attempted the reform of our environment, giving way to private interest, fearing to incur expense, lacking

in faith and vision, something now will have to be done, and done rapidly, the moment the War ceases and national effort turns to the needs of peace. New houses, new roads, new factories must be constructed—the dilatory method of a five-year plan which takes twenty-five to accomplish, will no longer serve: either these buildings and means of communication will be huddled up or laid down on their old sites, perpetuating the old conditions (with slight tactical improvements) and leading to the old problems of wasteful existence, or the opportunity will be seized and some good at least be created to make up for the monstrous loss through the War.

It is to prepare the way for a full use of this opportunity that Mr. and Mrs. McAllister have written their prelude to post-war reconstruction: they do not, as yet, attempt to plan, but provide us with the background upon which planning should be based; in this same series and also under the ægis of the Town and Country Planning Association, a future volume by Mr. F. J. Osborn will forecast the lines upon which planning, to fulfil its function of providing an environment, healthy, convenient and beautiful, should proceed. The McAllisters' task is the very necessary and preliminary one of setting forth the magnitude of the work against a historic background, showing how the standards which we must aim at are part of a process of evolution which is continually advancing.

I have mentioned three of the main objectives of planning—housing, industrial location and transport; to these should be added agriculture (which requires special treatment as compared with most other forms of industry) and recreational open spaces (both inside the town and outside). This book is more particularly concerned with the housing aspect: as the authors say—". . . informed opinion, the technical town-planners . . . and perhaps most of all those who approach town-planning not as experts but as sociologists, interested in humanity and anxious for that progress which good environment can achieve, must begin . . . by a consideration of *the needs of the family*". They have accordingly dwelt upon the standards of design, space and density required for the good family life. They recapitulate, familiar though the figures may be, the bad effects upon health of unsatisfactory home conditions and especially they insist upon the advantage of the house in its garden as compared with the dwelling in its tenement block. But they point out clearly the dilemma which the continued growth of the great towns forces upon the home-seeker: "either suburbia and a garden and a tedious daily journey or flat life and no garden and an environment unsuited to family life". On the other hand they show how necessary it is to integrate the different aspects of community life. Readers of NATURE are familiar with the biological triad, environment, function and organism, translated by Patrick Geddes into place, folk, work. The authors show that a dormitory housing estate "divorced from industry" is insufficient; that a trading estate is an "atrophied, unbalanced development" without provision for residence. They then build up this admirable picture of all-round development: "Put a Trading Estate and a good housing estate together and you have roughly two-thirds of a town. Add to them facilities for shopping, for social life, for education, for entertainment, and you have four-fifths of a town. Limit the size of the town by encircling it with a belt of country, devoted exclusively to agriculture and to recreation and prohibit all building development within the belt, and you have a town that satisfies human needs. . . ."

This could scarcely have been better put and we can therefore forgive them if 142 pages out of 168 are given to housing, as this is the authors' special subject, and they have made it abundantly clear that they realize, and make the reader realize, the position of housing in the urban complex. The last two chapters, indeed, are a useful summary of planning powers and needs, both local, regional and national. They give a brief description of the position of statutory town-planning at the outbreak of the War and direct attention to its predominantly permissive character as compared with the positive constructive planning now required, not only to make good the destruction from bombing but also to provide for a proper location of houses and industry when the general dislocation which obtains to-day is to be reintegrated.

The main body of the book covers the many aspects of housing, including two useful chapters on building costs and organization of the building industry. It will be remembered that high building costs broke the Addison Housing Scheme after the War of 1914–18, and it is to be hoped that drastic steps will be taken to prevent a recurrence; after this War the rush for building will be much more intense, so that the capacity of the industry to cope with it is of vital importance. Costs and capacity to build are closely interrelated.

From the above brief summary of this closely packed volume of information, it may be judged how useful it should prove both to the general public which should be fully informed, as well as to official bodies, both local and governmental, which, of course, have the information, but sometimes can learn from an unofficial presentation of the facts.

PATRICK ABERCROMBIE.

COMPUTATIONS IN NAVIGATION

Marine Navigation
By Lt.-Comdr. P. V. H. Weems. Pp. x+443. (London: Chapman and Hall, Ltd., 1941.) 30s. net.

WHILE we may applaud Lieutenant-Commander Weems's efforts to simplify, to shorten and even to obviate the computations incidental to navigation, we cannot but regret his verbosity and his lack of lucidity. It is difficult to see for whom his book has been written. It would confuse and might well mislead a beginner. It will prove tiresome to an old hand trying to bring himself up to date, who will have to refer to the index and turn up several pages before he can arrive at a complete account of the new method and an example worked by it. A case in point is that of star altitude curves. A sample page showing some of the curves is given on p. 334, directions for use and some sort of explanation on pp. 353–57 and a worked example on p. 367.

Many of the diagrams are clear and self-explanatory; others are cluttered up with lettering. Many of the illustrations are too dark, or on too small a scale: others are redundant.

There is, however, much that is of interest. In Chapter 3 we are introduced to a set of five blank charts, WSN charts, devised by three cartographers at the author's request. We gather that they are adaptations of Lambert's conformal projection and that they preserve angles and represent great circles by straight lines with sufficient accuracy for the purposes of navigation. The distance and the initial and final courses on each of four great circle tracks have been taken from these charts and compared with those found by full-dress solutions of the spherical triangles. The differences are all insignificant. We may take it, then, that these WSN charts are as quick and handy for great circles as those of Mercator for rhumb lines. We may also accept the author's method of determining the directions of rhumb line chords of a great circle. But WSN charts are blank and "A sensible navigator would never compute and sail a course without referring it to a regional chart" (p. 110), that is, in effect, to a Mercator's chart.

In Chapter 10, on radio navigation, we hoped to find the latest methods of laying down a position line obtained from a wireless bearing. The position line is not mentioned: we are told to convert the great circle bearing to the mercatorial bearing and to plot the rhumb line. Curves of equal (constant) bearing are only mentioned in the title of a picture of a chart of the North Atlantic on which two families of them have been drawn. But one cannot talk away the fact that when the difference between the great circle and mercatorial bearings is significant, so also is the angle between the curve of constant bearing and either of the other two curves.

The chapters on celestial navigation are more satisfying. The rudiments of nautical astronomy are clearly and simply explained in a way that should help a beginner. Those that deal with the latest forms of almanacs are of interest. Lieutenant-Commander Weems has personally instigated and contributed to innovations that have reduced both the time and labour of working a sight.

Of the computations that a navigator cannot avoid when translating observed time and altitude into a position line the longest is the solution of the spherical triangle determined by a local hour angle (L.H.A.) and the declination of the body observed and an assumed latitude. With an almanac of the older pattern the computation of L.H.A. involved the determination and the application of the error of the watch on G.M.T.; the extraction of two elements (one only for the sun) from the almanac, entailing interpolation; the application of these and an assumed longitude to the observed time. The use of second setting watches and frequent time signals obviates the first step. An account of these watches and also of sidereal watches is given in Chapter 17. The U.S. Nautical Almanac and the British Air Almanac now tabulate the Greenwich hour angle and provide appropriate tables to reduce it to L.H.A. by interpolation, thereby shortening the remaining steps.

For the solution of the triangle, more than one set of tables has for long provided the answer by inspection and interpolation. All of them are voluminous, and but few navigators appear to use them. The tables of the Brazilian Aquino, for solution by division into two right-angled triangles, are handy and quick. They deserve more attention than they have received. At this stage we would join our author (p. 335) in impressing on navigators that much interpolation is saved without significant loss of accuracy by suitable selection of the assumed latitude and longitude. The tables published by Lieut.-Commander Weems are for the same solution as those of Aquino and appear in his "Line of Position Book", sample pages of which are included on pp. 342, 343. They are quick, easy to use and, so far as we can tell,

sufficiently accurate. On pp. 362–65 a sight is worked by them and also by other similar tables for purposes of comparison. To judge by the number of figures used, Lieut.-Commander Weems's "Tables" and Hughes's "Sea and Air Navigation Tables", which appear to be identical, win in a dead heat.

The star altitude curves, referred to in the first paragraph of this note, are curves of equal altitude of certain selected stars, numbered to allow for refraction and plotted on a Mercator's chart. Their object is to provide a very quick means of obtaining a complete fix. The directions for use are explicit enough and that use is not limited to the selected stars. The explanation of their why and wherefore would puzzle a beginner. We have not tried them out.

G. V. RAYMENT.

PSYCHOLOGY FOR STUDENTS

A Biological Introduction to Psychology
An Introduction to Psychology for Students and Practitioners of Medicine. By Prof. R. J. S. McDowall. Pp. xiv+210. (London: John Murray, 1941.) 6s. net.

THERE are innumerable introductions to psychology, but few claim the distinction of being "biological" introductions. One therefore turned to this book, which was written by the professor of physiology at King's College, in the expectation that it would be something unusual. It might have been expected, for example, that it would have been written on evolutionary lines or along the developmental levels of the nervous system, since biology is mainly a study of increasing complexity in animal life. It might have progressed from the simple reflex to the greater complication of chained reflexes and thence to the instinct, the control of instinctual urges and the emergence of consciousness, the properties of memory, forgetting, and finally with the abnormalities associated with deranged function, so as to make a coherent whole.

Unfortunately, Prof. McDowall has not chosen a biological plan but has made an effort to make his book all-inclusive and so introduced unnecessary complication. He commences with a short section on adaptation. He then considers conscious activity, but follows this with processes of the nervous system. He proceeds to life's motives and the instincts. This section on the instincts includes the security instinct, the sex instinct, the power urge, and the spiritual urge. (It will be seen from this that Prof. McDowall does not adhere to the usual conception of the instincts, but adopts Adlerian theories and, in the spiritual urge, views which would be unacceptable to a large number of psychologists.) The last section of the book includes personality, reasoning, suggestion and hypnosis, dreams, the effects of mental states on bodily reactions, and the evolution of the individual.

There are a certain number of mistakes which are regrettable. For example, on p. 48, the author says "These phobias, or 'fixations' as they are sometimes called," and again on p. 49 he states "Many (i.e. phobias) are so deep, so fixed and so difficult to eradicate that in psychological parlance they are known as 'fixations.'" Such statements seem to show that Prof. McDowall does not appreciate that a fixation is a special term concerning emotional development in relation to the causation of neurosis or psychosis.

It would be unfair to condemn this book for such mistakes. It is a reasonably good introduction for the student as long as he is prepared to find it merely an introduction to psychology without having any special merit by being "biological". Moreover, it will please many by being essentially of the common-sense type, avoiding undue adherence to any particular school of psychological thought and making any assertions which need other than a superficial knowledge of psychology to appreciate. The style of the book is pleasant and friendly, and obviously inclined to lead the student gradually on from section to section.

There is a short appendix, which contains a number of case notes taken from Ross's "The Common Neuroses", Henderson and Gillespie's "Text-book of Psychiatry" and Howe's "Motives and Mechanisms of the Mind", etc. It is a merit of the book that it is not padded out with case notes, and those who write psychological books are well advised to follow Prof. McDowall's plan of placing case notes in a separate section so that they can be read apart from the text. The index is good and quite sufficient for a book of this kind. It would have been a good plan if a wide bibliography had been added, however, since an introduction of this kind should lead the student on to wider and more comprehensive reading. This would allow him to fill in the superficialities inevitable in an introduction and to correct the mistakes which have slipped into the text.

THE RISE OF SCIENCE IN RUSSIA

By ENG.-CAPTAIN EDGAR C. SMITH, O.B.E., R.N.

IN 1698, on February 6 and again on March 8, Peter the Great visited Greenwich Observatory, and as Flamsteed recorded, made observations of Venus. In Holland he had studied astronomy and other sciences, he had inspected Leeuwenhoek's microscopes and Ruysch's anatomical collections, and thus while pursuing his main object of learning shipbuilding and recruiting instructors and artisans, both in Holland and England he made himself acquainted with some of the science of the day. He was then about twenty-six years of age. Twenty years later he again visited Holland, but this time went on to Paris where he inspected the Arsenal, tapestry and printing works and natural history collections, went to the Sorbonne and Observatory and attended a meeting of the Royal Academy of Sciences, where he talked of maps. The newly founded city of St. Petersburg had already become his seat of government, in preference to Moscow, and one of his cherished ambitions was to establish in it an academy after the fashion of the Paris and Berlin Academies of Sciences and the Royal Society of London.

This scheme, however, Peter did not live to carry through, and it fell to his widow and successor, Catherine I, to inaugurate the Imperial Academy of Sciences, which for two hundred years was the scientific centre of the Russian Empire. The Academy was established in 1725, and it was at the last ordinary meeting of the Royal Society presided over by Newton that a letter from the Academy was read giving an account of its inauguration. Though the City and the Academy have changed their names (and the latter its location) they both are monuments to Peter the Great, who was the first to open the hitherto closed portals of his Empire to scientific thought and knowledge.

It is perhaps unnecessary to dwell on the backward state of Russia in the seventeenth century. Though the Empire stretched from the Baltic to the Pacific, from the Arctic to the Caspian, there were few schools and no universities. Russia can lay no claim to a Copernicus, Kepler or Galileo; and the older histories of science can be searched in vain for the names of Russian contributors to natural knowledge. When the Academy of Sciences was in the making it was therefore necessary to draw its members from other lands, and so from France came its first astronomers, from Switzerland its first mathematicians and from Germany its first naturalists, and right throughout the eighteenth century, not only men of science, but also others learned in history, languages or architecture or skilled in painting, mechanics or engineering, were recruited from western countries by succeeding sovereigns. All these men were made members of the Academy of Sciences, provided with comfortable homes and adequate pensions, and St. Petersburg was the main centre of their activities.

Among the earliest to arrive in St. Petersburg were the French astronomer Joseph Delisle (1688–1768) and his brother Louis Delisle de la Croyère, and the Swiss mathematicians, Nicolas Bernoulli (1695–1726), his famous brother Daniel Bernoulli (1700–82) and James Hermann (1678–1733). Then in 1727 came Leonard Euler. He was then only twenty years of age, but he was destined to shed more lustre on mathematical science in Russia than any other individual. It is said that about half the memoirs in the *Transactions* of the Academy came from his pen. Joseph Delisle remained in Russia for twenty-one years establishing an observatory and lecturing to many students. His brother Louis Delisle de la Croyère served the State in various ways and perished with Behring on Behring Island in 1741. Nicolas Bernoulli died in St. Petersburg about a year after his arrival there, Daniel returned to Basle in 1733 while Hermann's stay was of the shortest. Three other men of science who were attracted to St. Petersburg in these early days were T. S. Bayer (1694–1738), who was given a chair of Greek and Roman antiquities, J. G. Gmelin (1709–55), professor of chemistry and natural history, and G. F. Muller (1705–83), who taught Latin, geography and history. The services of Muller led to his being called the "great father of Russian history".

One of the urgent needs of the Russian Government was a better knowledge of the many lands and races under its jurisdiction. Peter the Great had felt this need and for a number of years employed the German physician and naturalist Daniel Messerschmidt (1685–1735) to travel in Europe and Asia. On his journeys in Siberia Messerschmidt had the companionship of one of the many Swedish prisoners of war Peter had sent there. In the reign of the Empress Anne quite a large expedition was sent to explore Siberia from the Urals to the Pacific. Behring, the Danish

navigator, Delisle de la Croyère, Gmelin and Muller were among the leaders of this expedition which left St. Petersburg in 1733 and did not return until 1743. Others who afterwards took part in the expedition were the Russian botanist S. Krascheninnikof (1712–54), the German medical man and naturalist G. W. Steller (1709–45) and the German savant J. E. Fischer (1697–1771), who became professor of antiquities at St. Petersburg.

For ten years Gmelin, Muller and their fellows explored the plains and mountains of Siberia from Tobolsk to Okhotsk, sailed on the great rivers Ob, Yenisei and Lena, searched for the remains of the great animals from which fossil ivory had long been obtained, and gathered together a great mass of information on this vast and sparsely populated land. Behring and many of his companions died in 1741 in the Far East, and Steller after being wrecked and suffering years of hardship regained touch with the home authorities only to disappear for ever. Great results were achieved by the expedition and it paved the way for that of Pallas referred to in NATURE of September 20, p. 334.

In the years which separated these two expeditions considerable strides were made in the furtherance of science in the capital. The reign of Catherine had been followed by those of Anne and Elizabeth, and in 1762 the great Catherine II ascended the throne. The University of St. Petersburg was founded in 1747 ; that of Moscow in 1755. Perhaps the most notable figure in St. Petersburg at this time was Michael Lomonosof (1711–65), father of modern Russian literature. Educated partly at the Academy, he had studied chemistry, mineralogy and metallurgy in Germany. In 1745, G. W. Richmann was made professor of experimental philosophy ; in 1747, Muller was made historiographer to the Russian Empire, and in 1751, A. N. Grischow (1726–60) became professor of astronomy and secretary to the Academy. In 1753, the year Franklin received the Copley Medal of the Royal Society, Richmann was killed by lightning when repeating some of Franklin's experiments. In 1757 the scientific coterie was joined by Æpinus, who two years later at St. Petersburg published his "Tentamen Theoriæ Electricitatis et Magnetismi", one of the great works on electricity in the eighteenth century. In 1760 Rumoffski published his "Course of Mathematics", said to be the first printed in the Russian language. Rumoffski had studied under Euler in Berlin and he was well known as a mathematician, astronomer, geographer, traveller and teacher. When more than seventy years of age he was curator of the University of Kazan.

With the accession of Catherine II in 1762 a new era in Russian education, science and literature began. Of German parentage, even her marriage to a boorish prince and her long acquaintance with the intrigues and boredom of the Russian Court could not destroy her love of books. She was fond, too, of patronizing learned men. She was able, in 1766, to prevail upon Euler to return to St. Petersburg from Berlin ; she entertained Diderot like a prince ; she asked D'Alembert to become the royal tutor and she sent her portrait to the Irish chemist and mineralogist Kirwan. Soon after Euler returned to St. Petersburg, he was joined by the Swedish astronomer, Lexell, and by Nicolas Fuss (1755–1825). These proved great friends to Euler in his blindness. In 1776 the Academy of Sciences celebrated its jubilee and in Weld's "History" will be found the letter of Euler's son, J. A. Euler, announcing that the Academy had elected the president of the Royal Society, Sir John Pringle, a foreign associate. Euler's death in 1783 left a blank in the Russian mathematical world never filled. He had thirteen children and of these Jean Albert (1734–1800), was the professor of natural philosophy, Charles (d. 1790), was a doctor at the Russian court and Christopher (d. 1814) rose to be a major-general in the Russian Army. His son-in-law Nicolas Fuss, in 1800, became secretary of the Academy of Sciences, in which post he was succeeded by his son Paul Henry. Another son, George Albert Fuss, was one of the first assistants at Pulkowa Observatory.

Towards the end of the reign of Catherine (who died in 1796), and during the reigns of Paul and Alexander I, scientific work seems to have languished somewhat. No doubt this was partly due to the disturbed state of Europe during the French Revolution and the Napoleonic regime. After this period of comparative stagnation science took on fresh activities during the whole thirty years reign of Nicolas I, who ascended the throne in 1825. Though a monarch who declared that "Despotism is the essence of my government, and it suits the genius of the land", yet he was not averse to giving his blessing to scientific projects and showering gifts on men of science. On one occasion he sent a diamond ring to James Nasmyth, the engineer ; on another he presented a fine china vase to Snow Harris, the electrician, and when Airy, the Astronomer Royal, was refused permission by the British Foreign Office to accept a Russian knighthood, Nicolas had a gold medal especially struck for him.

Soon after Nicolas came to the throne the Academy of Sciences put forward a plan for a new central observatory. Nicolas, through his minister, replied in 1830 "that the honour of the country appeared to him to demand the establishment, near the capital, of a new astronomical observatory,

conformable to the actual state of Science, and capable of contributing to its ulterior advancement". In 1835 the foundation stone of the great Pulkowa Observatory was laid and in 1839 the institution was completed at a cost of about £100,000. It stands about ten miles south-east of Leningrad and unfortunately is now in the defensive zone of that city. Directed from 1839 until 1890, with but a brief break, by the Struves, father and son, it became a Mecca for astronomers, and Gould, the American astronomer, once called it "the astronomical capital of the world". The Struves had many able assistants and they were visited by eminent astronomers from all over the world. Russia was also greatly indebted to the Struves for their geodetical work which included the measurement of an arc of the meridian from the north of Scandinavia to the River Danube. When Otto Struve retired he was succeeded by Theodor Bredikhine (1831–1904) who previously had been professor of astronomy at Moscow, and he in turn was succeeded by Johan Backlund (1846–1916), who though Swedish by birth became a naturalized Russian.

The Government of Nicolas also did much to further magnetic and tidal observations and geographical and geological excursions. In 1828, Hansteen, the Norwegian physicist, accompanied by the German physicist, G. A. Erman, travelled to Siberia making magnetic observations, and their journey was followed by that of the great Humboldt who was accompanied by Ehrenberg and Gustav Rose, the chemist and mineralogist. It was Humboldt who put forward the plan for a world magnetic survey in which Great Britain and Russia took the leading part. Another expedition of note was that made in 1841–45 by Murchison, the French geologist de Verneuil and the Russian mineralogist N. I. Koksharov (1818–93), who, in 1865, became director of the Imperial Mineralogical Society of St. Petersburg. Two other eminent Russian geologists of this time were Gregor von Helmersen (1803–85), who, in 1841, published a geological map of Russia, and K. E. von Eichwald (1795–1876), professor of palæontology at St. Petersburg. The greatest naturalist of the reign of Nicolas in Russia, however, was the German, Karl E. von Baer (1792–1876), to whom the Royal Society in 1867 awarded the Copley Medal; this being the first time the medal had gone to Russia. Since von Baer's time it has been awarded to Metchnikoff, Mendeléeff and Pavlov.

It may be presumed that during the eighteenth century German and Swedish works on chemistry, mining and metallurgy found their way into the mining districts of European Russia and Siberia, but chemistry does not appear to have occupied an important place in the schools and universities. A Russian chemist whose name is mentioned in histories of chemistry is Klaus, the discoverer of ruthenium. Klaus was a professor at the University of Kazan founded in 1804. Among his students and contemporaries were Nicholas Zinin (1812–80) and Alexander Butlerow (1828–86). Both these men occupied chairs first at Kazan and then St. Petersburg. Another student and professor at Kazan was Wladimir Markownikoff (1838–1904), who in 1873 was given the chair of chemistry in the University of Moscow. Other leaders in Russian chemistry at this time were Friedrich Beilstein (1838–1906), Nicolas Menschutkin (1842–1907) and the great Mendeléeff, who was born at Tobolsk in 1834, being the youngest of the fourteen children of the director of the Tobolsk College. Mendeléeff's grandfather had produced the first Siberian newspaper.

Appreciations of these distinguished chemists are to be found either in the columns of NATURE or the *Journal of the Chemical Society*. Several of them made important investigations concerning the petroleum of the Caucasus, but it is worth recalling that it was the Swedish engineer Ludwig Nobel (1831–88), elder brother of Alfred Nobel, who revolutionized the Baku oil industry and introduced pipe lines, tank cars and tank steamers, making a fortune where others had failed.

The most famous scientific man connected with the University of Kazan was Nicolai Lobatschewski (1793–1856). "What Vesalius was to Galen, what Copernicus was to Ptolemy, that was Lobatschewski to Euclid", wrote Clifford. Kazan owed much to his organizing powers, and forty years after his death his bust was placed in the University and a prize founded in his honour. In human interest even Lobatschewski is surpassed by the remarkable woman mathematician, Sophie Kowalevski (1850–91). Her romantic marriage to Woldemar Kowalevski (1843–83), professor of palæontology at Moscow; his tragic death and her subsequent rise to fame make a story as interesting as one of her own novels. Her reputation was such that in 1886, when she was holding the chair of higher mathematics at Stockholm, the Paris Academy of Sciences broke through all the traditions of two centuries by admitting her to one of its meetings. As she entered, the whole of the members rose to salute her and the president declared that her presence should be a cause of pleasure not only to the mathematicians present but also to the whole company.

If space permitted, something might be said about the rise of engineering in Russia. One of Smeaton's last atmospheric engines was fitted up at Kronstadt, and both Smeaton and Watt were invited to Russia in the days of Catherine II. The first engineering shops in St. Petersburg were

set up by British engineers, among whom were the Bairds, Handyside and the younger Matthew Murray. The early history of the engineering and other industries in Russia, however, is receiving the attention of Prof. P. P. Zabarinskij and other members of the Institute for the History of Science and Technics of the Academy of Sciences of the U.S.S.R., and already many interesting documents and facts have been brought to light and published.

PRESENT-DAY SCIENCE AND TECHNOLOGY IN THE U.S.S.R.

By PROF. J. D. BERNAL, F.R.S.

SCIENCE is a collective human enterprise. It belongs to no country or race. Yet at different periods it has owed its chief advance to the activities of men first in one part of the world and then in another. Modern science originated in Italy in the sixteenth century, spread to the Low Countries, and thence to England and France. It was in England that it first achieved effective organization in the Royal Society. The nineteenth century saw it established in every industrial country of the world, notably in Germany and the United States. In each of these countries a characteristic contribution was made both to the extent of new knowledge and to the new means of gaining it. In this century, the contribution that the new Union of Socialist Soviet Republics has made to science is as significant as any of the major contributions of other origins in the past.

Science, of course, was not a new thing in Russia. It can date its introduction as a living force to the many-sided genius of Lomonosof in the eighteenth century; and Russians can well be proud of the achievements of such men as Mendeléeff and Pavlov. But all these were relatively isolated workers. In no sense could the state of science in Russia before the Revolution be compared with that of Germany or Great Britain. The great change which the revolution brought about was to make conscious for the first time the necessary connexion between the ordered development of science and the life and work of the whole community. In this, of course, the new Government was inspired by the ideas of Marx and Engels, who had taken a lifelong interest in the progress and importance of science. Lenin had a wider and deeper knowledge of science than any statesman of his day, and even in the most difficult period of famine and civil war he laid the foundations of an entirely new development of science.

The conscious utilization of science, though to a certain extent implicit in State scientific institutions such as the Kaiser Wilhelm Gesellschaft in Germany and the Department of Scientific and Industrial Research in Great Britain, was foreign to the Western democracies; and this has made it difficult for many scientific workers to understand and appreciate the achievements of Soviet science. The task that was undertaken was not to push forward the bounds of knowledge by the work of a few isolated specialists, but to make scientific the whole productive and cultural activity of 160 million people, only a tiny minority of whom had any previous acquaintance with science or technology. The first twenty years of the Republic's life was occupied in a double task: the building up of scientific education, and the application of science to industrial, agricultural and medical needs. It was first necessary to create a body of competent scientific workers, starting from the handful that had sufficed for the needs of the Tzarist State. In 1919 there were only forty trained physicists in the whole of the Union. New schools, new universities, new scientific research institutes had to be founded and manned, and the necessary scientific instruments manufactured for them. Meanwhile, immediate problems of electrification, communications and agriculture had to be solved. This gigantic task could only have been achieved because it had behind it the enthusiastic interest and support of the whole people. It is characteristic of times of rapid progress and reconstruction that interest in knowledge should reach new heights. It was so at the dawn of the Greek City State, in the Italian Renaissance, in Civil War England; and it was certainly so not only for the Russians, but also for the submerged subject races of the old Empire—Mongols, Kazaks, Turkmen, Tartars, Georgians and Armenians.

In the creation of a new world it would be idle to look for the quietly pursued excellence and sound and acute scholarship that characterize an old-established and stable society. Science in the Soviet Union is not like science in Denmark or Switzerland. Nevertheless, the contribution to the advancement of knowledge made by the Soviet Union has been marked and important. In certain fields, especially in technology, Soviet discoveries

and applications have already made a deep impression abroad. In physics, for example, the work of the Leningrad School on the mechanics of crystal deformation was the starting-point of much of the recent great advance in the understanding of the strength of materials and of ways of improving them.

The Soviet Union has also led in the application of low-temperature techniques to industrial uses, particularly for oxygen, hydrogen and methane, where Prof. P. Kapitza's new processes are being energetically developed. Proposals for radical innovations, such as underground gasification of coal, eliminating at one stroke the whole of the laborious task of the miner, are characteristic of the Soviet approach. The widespread and strictly scientific survey of mineral resources has already led to discoveries of new mineral deposits exceeding all expectations.

In agriculture, the advantages of a common scientific basis and the removal of obstruction from tradition or vested interest have led to remarkable developments, notably in vernalization, the production of new hybrids such as perennial wheat, and the improvement of stock through artificial insemination. The development of public health services on a universal and rational basis has probably contributed more than anything else to immediate human welfare, and the new and universal use of stored blood for transfusion is largely due to Soviet initiative.

It is not in these achievements, however, that the ultimate value of the developments that have taken place in the Soviet Union is to be found. They are, so to speak, only an indication of what is to come when the principles of the organized development and utilization of science can be fully carried out, not only in the Soviet Union but also in the world at large. Nothing has aroused such interest, and at the same time such opposition, in scientific circles as the idea first adopted in the Soviet Union of the planning of science. The opposition is now largely silenced, because the conditions of war have made most scientific workers realize in their actual practice that planning is not only necessary, but is also quite compatible with individual initiative and enterprise. Curiously enough, the very consideration of a science planned in relation to social needs brings to light new problems, which in themselves act as a stimulus to radically new discoveries, by breaking up traditional associations of ideas which are the most effective bar to progress.

The actual system of planning which has been evolved in the U.S.S.R. in the past twenty years is much more comprehensive and more closely integrated with the life of the country than anything in Great Britain even in war-time. The general direction of research is in the hands of the Academy of Sciences, which has grown from being an honorific society into a body controlling directly the research of some thousands of workers mainly on fundamental problems. The Academy is closely linked with the universities, which have grown enormously in number and size while steadily improving the standard of their scientific teaching. All university students are selected for ability and are supported by the State, as are the new science bursaries in Great Britain. In return, they must accept four or five years of work allotted to them after graduation. This system ensures an ample supply of the best brains for scientific and technical work. Already in 1934 the proportion of young men and women going to the university was five per cent, as against two per cent in Great Britain. Allowing for the greater population and for the fact that a far larger proportion take science, the annual output of scientific workers must be about twenty times what it is in Britain.

The greater part of the short-term research is carried out in the institutes of the commissariats of industry, agriculture and health. Research and development are closely linked, and the scientific workers are close to the problems arising in the workshop and the field. The actual plan of research is not imposed from above, but evolved after much discussion by the scientific workers themselves. It does not, however, stand by itself but is closely linked to the State Planning Commission, and thus forms part of the general production and cultural plan of the Union. The major short- and long-term problems are set by the needs of the country as a whole. How they are to be solved most quickly and effectively is left for the scientific workers themselves to determine. That is the essential safeguard for seeing that fundamental work is not neglected. The result of this integrated effort goes much beyond its immediate practical application ; it is producing a society that is scientific through and through.

The difficulties which, particularly in the years preceding the War, surrounded the work of Soviet men of science have often led to doubts in the rest of the scientific world as to the ultimate efficacy of the system adopted. The bitter test of war is showing that in this field also the Soviets were building better than we knew. It is to be hoped that, fighting together in a common cause, scientific workers in Great Britain will come to understand, far better than from any description, the new spirit and method which characterize science in the U.S.S.R., and that, in turn, we may be able to provide some of the advantages of a long tradition of discovery and criticism. The new world for which we are all fighting and working will need every contribution that science can bring.

BIOLOGICAL SCIENCE IN THE U.S.S.R.

By Dr. Joseph Needham, F.R.S.

THIS contribution is intended to be complementary to Prof. J. D. Bernal's account of science and technology in the U.S.S.R. It is obviously impossible for one scientific worker to do justice to all the many sides of work in such a vast field as biology in the Russian world, but in this respect I am so far happy that in some of the departments with which I am familiar, such as experimental morphology, the Russians have won a position of generally acknowledged leadership.

It is certainly true that since the Revolution of 1917 science has enjoyed greater State support, both moral and financial, than in any other country. But it seems on the whole that, owing to the policy of concentration on heavy industry and all those branches of science which connect with it, biological science rather lagged behind physics and chemistry. I visited Russia in 1935 in connexion with that very successful organization, the International Physiological Congress, and although my impression in viewing Russian laboratories at that time was that the general standard of work was not up to the best standards in Western countries or in the United States, I formed the belief that its upgrade was faster, and that parity would before long be reached or passed.

In biochemistry this has proved to be the case. Two instances of fundamental biochemical discoveries recently made in Russia may be given: first the identity of adenylpyrophosphatase with myosin itself by Engelhardt and Ljubimova. This connected for the first time the energy-providing phosphorylation cycles with the contractile machinery, since myosin is the contracting protein. Secondly, the elucidation of the phenomenon of trans-amination by Braunstein and Kritzman, revealed the transfer of nitrogen in the living cell parallel with that of phosphorus and hydrogen, about which so much is known. An interesting sidelight on the freedom of choice of work in Russia is that the biochemists at the Military Medical Academy at Leningrad specialized on problems of chemical embryology—an exceptionally unwarlike subject—in which valuable contributions were produced by Galwialo, Vladimirov and their colleagues. Similarly, the well-known vitalist and founder of the mitogenetic ray hypothesis, Gurwitsch, has always retained his chair in Moscow, in spite of his differences from official views. Little is now heard of this subject in any country, but it is well to remember that the majority of the work which claimed to support the existence of the rays was done outside Russia, and that some of its first and most sharp critics were Russian, such as Moissejeva of Kiev.

In experimental morphology and embryology there were formerly two main schools, one American, dealing with the development of invertebrates, the other German, dealing with that of vertebrates. Since 1933, the workers in this field, which in view of its German origin bears the name *Entwicklungsmechanik*, have almost all gone into exile, and the mantle fell upon the newer Russian school. Among its leaders were Koltzov (who so long ago as 1912, with but the Fischer polypeptide chain theory to go upon, suggested that the chromosome might be considered a giant protein molecule with the genes as side-chains), Schmalhausen (author and encourager of important work on growth-rates), Balinsky, Filatov, Dragomirov, and others. Balinsky and Filatov have specialized on the induction of the nose and ear; they discovered the extraordinary powers which nasal placode and ear-vesicle have in inducing limb-buds on the flank of the amphibian neurula. Umanski discovered the induction power of cancer tissue, and explored the integrity required in tissue responding to neural induction. Wolffian regeneration of the lens of the eye has been intensively studied by Popov, Manuilova and their colleagues. In this literature it is interesting to note the appearance of names such as Sikharulidze and Murtasi from those Near and Central Asiatic races which hitherto have never had an opportunity of contributing to the advance of science.

One characteristic line of attack developed by the Russian experimental morphologists is the fusion together of several pieces of the same material, a technique possibly suggested by, and certainly in line with, the dialectical materialist idea of the transformation of quantity into quality. Thus Lopaschov, in important work, surveyed the results obtained in differentiation when from one to ten organization centres are isolated and grown together. Similarly, Polezaiev went far to settle the disputed question of whether limb-bud blastemas are undetermined or not by transplanting several of them at once, not only one (which is often resorbed), on to the new site. In this way it was found that development is always selfwise (*herkunftsgemäss*). The problem of the loss of regeneration competence has been much studied by this worker, with Schaxel, Liosner, Voronzova, and others, while the biochemical aspects of the

regeneration process, never before explored, have been investigated by the school of Okunev, Blacher, Orechovitch, Kozmina, Vladimirova and many more. The association of the action of various proteolytic enzymes with the differentiation processes proceeding in parallel has thus been studied. Another case of comparisons between chemical and histological data would be the study of insect metamorphosis, which has been successfully pursued by Demjanovsky, Zolotarev and others; or the respiratory studies in fish development by the school of Trifonova.

It seems specially worthy of remark that the far-reaching support of experimental morphology in the Soviet Union has occurred in a country where, according to a common opinion, only research of immediate practical applications would be expected to find support. The fact is that no one can tell what practical applications a science may have. The Russians have, as it happens, benefited greatly by their backing of this pure science, since increasing knowledge of eye-transplantations has permitted of the grafting of parts of the eyes of dead persons into living blind patients, leading to the restoration of their sight. This operation is associated with the name of Filatov.

On the borderline between physiological morphology and genetics a great deal of work has been done. There is space only to mention the work of the Iljins on coat colour, of Rappoport on the production of phenocopies by treatment of flies with salts of metals, and of Vassin, who recognized in a naturally occurring semi-lethal genetic abnormality the persistence of the embryonic gill-slits, in sheep.

In pure genetics also there has been a vast effort. Vavilov, one of Russia's greatest men of science, travelled over the whole world and made collections of plant material which have no equal. A great deal of work is still being produced by his school, which came into conflict, in a celebrated controversy, with that of Lysenko (who has been called the Burbank of the Soviet Union). Lysenko was originally a plant physiologist who discovered a method, known as vernalization, of producing a spring-sown cereal from a winter-sown one—owing to the Russian winter climate a most desirable thing. It is not yet certain whether this achievement will have world-wide application. Later, Lysenko and his school became extremely critical of the generally accepted principles of classical Mendelism, and they are now repeating many of the fundamental experiments on which Mendelian theory has been based. Only time will show whether their experiments on the inheritance of acquired characters will have the same results as all previous such experiments, or whether perhaps in the process some valuable information, hitherto overlooked, will accrue. Some geneticists believe that some of Lysenko's results may be explained by virus infections. In any event, this controversy is an outstanding instance of the benefit which would be derived could the scientific workers of the Soviet Union in the future come into much closer contact with those of other countries.

Where genetics touches animal husbandry enormous progress has been made in Russia. The Soviet improvers of stock have not been hampered by the difficulty which exists in other countries, namely, that the pedigree breeds are in private ownership while the mass of cattle are unimproved. Artificial insemination, introduced by Ivanov and others, is practised on a large scale, permitting the wide dissemination of useful qualities.

In the foregoing survey, little has been said about the Russian zoological and botanical systematists, but I understand from competent colleagues that they have been worthily keeping up the great traditions of the last century on the foundations laid by Pallas and von Baer. A word should be added, however, about the marine biological stations, of which there are several; at least one near Murmansk, another on the Crimean coast, and a third near Vladivostock. The first-named of these produced valuable work on comparative biochemistry by Kreps and Verjbinskaia, and on comparative physiology by Koschtojanz; the third aided Okunev's work on regeneration. There are, moreover, certain special stations of interest, such as that at Sukhum-Kale on the Caucasian coast, devoted to the experimental neurology of apes, perhaps the only one existing anywhere apart from the Physiology School at Yale University.

In conclusion, a word on the facilities available to Russian biologists. My impressions are that work in a Russian laboratory resembles closely enough work here in Great Britain or in the United States, with the exception that there are considerably more technicians available for the use of the research workers, enabling them to concentrate on what is their proper business, the planning, carrying out, and interpretation of experiments. The subject of pay and opportunities cannot be dealt with here, but reference may be made to a contribution by Dr. M. Ruhemann on this subject in NATURE[1].

There can be no doubt that the U.S.S.R. has a vast contribution to make to world science, a contribution with a special quality that cannot be spared. We must hope that, after this War, contact between the scientific workers of the democracies and those of the Soviet Union will be far more intimate than what has been possible in the past.

[1] NATURE, 141, 792 (1938).

PROPAGATION OF RADIO WAVES ROUND THE EARTH

By T. L. ECKERSLEY, F.R.S.
MARCONI'S WIRELESS TELEGRAPH CO.

CONSIDERING the use to which the transmission of radio waves is put, it is remarkable how few have studied the problem. Engineers are interested in the terminal apparatus—the great transmitting and receiving stations; and physicists seem to be more interested in sending radio waves to themselves in the investigation of the ionosphere than in studying the transmission to others across wide open spaces. Both activities are essential to the creation of communication links, but a study of the application of the results obtained by physicists and engineers is also essential.

The mechanism of radio transmission is the same as that of light. Both comprise wave motions in the ether, but the wave-lengths used in radio, although covering a wide range, are very different from those of light.

Radio waves vary from a few centimetres to 20–30 kilometres, that is, sixteen or more octaves. Light waves are of the order of 10^{-7} cm., and there is only about one octave of visible light. The enormous range of radio waves makes the study of propagation difficult, but at the same time most interesting. Different wave-lengths have been treated piecemeal by different methods, but there should be, and is, one general method by which all problems can be treated.

The earth is practically a sphere, and for theoretical purposes it can be treated as a homogeneous sphere of uniform electrical conductivity. Irregularities do not matter much to the first approximation.

The propagation of radio waves round such a sphere can be treated mathematically. This was originally done by the great mathematicians such as Poincaré, and others. The mathematics are difficult. They were put on a firm and unimpeachable basis by G. N. Watson at the instigation of Van der Pol. Watson's investigation showed that for long waves the earth behaved as if it were a perfect conductor, and the results are only applicable, without further development, to perfect conductors. The whole theory has now been developed in two independent ways which agree and are applicable whatever the conductivity or inductivity may be.

The results of this mathematical investigation are now clear and definite enough. Waves of which the length is small compared with the radius of the earth are, as in light, practically confined to the region above the plane which is tangent to the earth at the transmitter.

The waves from the transmitter travel out in straight lines, and most, practically all, of the earth is in shadow. Nevertheless, some radio energy can penetrate by diffraction into the shadow region, and the longer the wave-length the more easily it does so.

However this may be, diffraction alone, or bending round the earth, is entirely inadequate to produce a signal at, say, the antipodes on any wave used in radio.

Diffraction is most effective when the wave-length is large, but even the longest waves that can be conveniently used in radio communication are so weak at the antipodes that they need increasing by a factor of the order of 10^{11} in order to overcome outside noise, even when the highest powers are used.

It is clear that in the normal radio range it is quite impossible to produce workable signals at the antipodes, or even at distances greater than about 3,000–4,000 kilometres, without the help of some agency which bends the rays round the world. This agency we now know is the ionosphere, which has been largely investigated by physicists in the last ten years. All the long-distance short-wave broadcasts, all the long-distance high-speed beam services, and all the linking up of 99 per cent of the world's telephones would not exist but for the ionosphere. The study of radio transmission round the earth therefore devolves itself into the study of the ionosphere and its effect on long-distance communication.

There are two aspects:

(1) The investigation of the constitution of the ionosphere.

(2) The exploitation of this knowledge in radio communication.

THE IONOSPHERE

This is a region from 60 to 300 kilometres above the earth, in which a small proportion of the molecules are ionized, so that there is an appreciable atmosphere of electrons capable of reflecting and modifying wireless transmissions.

It is only recently that a detailed and fairly accurate knowledge of it has been obtained, by Appleton in Great Britain and by experiments initiated by Breit and Tuve in the United States.

The method by which the ionosphere, which at 100 or more kilometres is entirely out of direct reach, can be investigated, is very simple in

essence. Radio impulses a fraction of a millisecond in length are sent up to the ionosphere, where they are reflected down to earth again. From the delay of the reflected echoes, their intensity and polarization, etc., a great many characteristics of the ionosphere can be deduced.

Measurements have been made at a large number of places on the surface of the earth, but the results are by no means sufficient. From these we know that there exists in all places examined a region between 60 and 300 km. above the earth in which there is an appreciable number of free electrons, reaching a concentration as great at 10^7–10^6 per c.c. This maximum density is an important characteristic of the layer. It is easily found with the impulse technique already described.

If the radio frequency of the exploring impulses is increased, their delay (that is, the time it takes for the impulses to travel up to the ionosphere and back) rapidly increases, and beyond a certain frequency the rays penetrate the upper layer and echoes cease. This critical frequency gives the maximum electronic concentration in the various layers of which the ionosphere is composed. Near the critical frequency, the curve which is known as the $P'f$ curve, relating delay time and radio frequency is split into two nearly circularly polarized branches, this being effected by the earth's magnetic field.

This critical frequency varies with the height of the layer concerned, the time of the day, season, epoch of the sunspot cycle, etc. It is possible, therefore, even with the limited observations at our disposal, to chart the world.

It is found, in effect, that wherever observations are taken, the curves relating delay and frequency are of the same general type, indicating the existence of three main layers, the E, F_1 and F_2 layers, approximately at heights of 100 km., 200 km. and 250–300 km.

A great deal has been found out about the ionosphere. Thus the E and F_1 layers behave normally and vary diurnally, seasonally and with the epoch in the sunspot cycle, as if ionized by the sun's ultra-violet radiation. The F_2 layer behaves in an anomalous manner. For example, contrary to expectation, the electron concentration in England is less in summer than in winter. Again, the concentration is different in the northern and southern hemispheres. There appears to be some annual ionizing agency independent of the sun.

By determining the polarization of the two branches of the $P'f$ curves near penetration in the northern and southern hemispheres, it has been found that the electron atmosphere is the major factor in guiding wireless waves. A positive ion atmosphere may exist in the lower E layer, but on account of the mass of the positive ions compared with the electrons, these have to be enormously in excess (10,000 to 1 or so) in order to affect the wireless waves. All we can say is that, experimentally, this excess does not exist.

One of the major factors in radio transmission is the attenuation of the waves. This is primarily caused by the collision of the electrons with the rest of the molecules. The electrons receive energy from the waves which is wasted as heat in collisions with the molecules.

By making experiments on the loss in reflexion as the impulses are delayed, it is possible to determine the collision frequencies at various heights, this quantity being of the order of 10^6 in the E layer and about 5×10^3 in the F layer.

The ionosphere is disturbed by the mechanism which produces magnetic storms, and also by bright hydrogen eruptions from the sun. This pathology of the ionosphere is of great consequence to communication engineers, and much has been learned about it.

PROPAGATION: GENERAL

With the help of this knowledge of the ionosphere, it is possible to get a very fair idea of the propagation of radio waves round the world, and to deduce, for example, which waves are least attenuated and can travel the greatest distances.

Short waves, 10–100 metres, which have been extensively used in world-wide communications, are easiest to understand because ray methods can be used; and, just as in optics, it is possible to trace the rays modified by refraction in the ionosphere. The analysis of these short waves is, in fact, a branch of optics; but when the wavelength becomes comparable with the radius of curvature of the rays, wave methods, and not optics, must be used. Attenuation also largely modifies optical methods, and for exactness and proper understanding, optical methods should be discarded and wave methods used everywhere. Nevertheless, it is sufficient to use optical methods on short-wave ranges.

The correct mathematical method, which should be applicable to the whole of the radio range, is to determine the solution of the equations of propagation in the ionosphere, in the region between the earth and the ionosphere, and in the earth itself, and to satisfy the boundary conditions at the surface of the earth and ionosphere respectively. The difficulty is in obtaining solutions of propagation in the ionosphere, which depend on fourth order differential equations when account is taken of the earth's field.

An approximate development of this is a phase integral method similar to that used in quantum mechanics, which, if the change of phase and

amplitude on reflexion at the ionosphere are known, is exactly equivalent to the above boundary problems. This phase integral often yields solutions in which methods are much simpler than in the boundary problems, and has been made to give a solution of the diffraction problem in which general relations of great interest are found. These methods—of universal significance—degenerate into optical ray methods for short waves (10–100 metres).

SHORT-WAVE TRANSMISSIONS

The application of our knowledge of the ionosphere is enormously helped by a proposition which translates the vertical $P'f$ results into relations for oblique transmission. Thus, if the critical frequency for vertical transmission is known, the critical frequency and consequently skip distance at oblique incidence are also known. This has been checked by an elaborate experiment between Chelmsford and Bodmin. With a sufficiently short wave, even the tangent ray escapes, so that even though it requires a much smaller electron concentration to bend the rays through a small angle, as in long-distance communication, there is ultimately a maximum usable frequency which is about four times the vertical critical frequency. Ground waves can, of course, be used at much higher frequencies. The above theorem is only exactly true if the earth's curvature and steady magnetic field are neglected.

The maximum usable frequency can be shown on a chart in which contours of the quantity are given. To the first approximation, the state of the ionosphere, and hence the contours of this chart, depend only on the sun's position. The chart can be drawn on transparent paper and slid over a map to give the maximum usable frequency for long-distance communication on any route. Complications in transmission may be produced by irregularities in the E layer, which are known to exist, but the cause of which is as yet unknown.

Short-wave transmission is very largely explainable on these optical lines. Each ray usually passes through the E layer up to the F layer, where it is reflected. In the passage through the E layer, it is attenuated by an amount proportional to the square of the wave-length. The shortest waves travel farthest provided they are not too short to be reflected.

LONGER WAVES

Experiment shows that above about 1,000 metres any increase in the wave-length increases the range, and extreme world-wide ranges can be obtained if waves of the order of 20–30 km. are used. These were originally employed in radio, until it was found that outside noise was so great on these frequencies, and the expense of the gear so high, that the use of such waves became uneconomic.

The behaviour of these waves can easily be explained, but not by ray methods. The boundary value or phase integral wave method must be used.

On these frequencies, 300 kc./sec. and less, there are no rays in the ionosphere, and we know that all the radio energy is confined to the E layer. The propagation in the E layer is not that of the propagation in a free electron atmosphere. Electron collisions with molecules are predominant, and the electrons do not move freely. The ionosphere behaves like a metallic conductor, and the parameter which controls the type of transmission is the ratio of the collision frequency ν_c to π times the actual frequency ν. When this quantity α is large, the ionosphere behaves like a conductor; when it is small, like an Eccles–Larmor refractive medium. In this, the rays reach a level where the concentration is proportional to the square of the frequency.

In a conductor, on the other hand, there are no rays at all, and the energy only reaches a level which varies inversely as the square root of the frequency.

The transmission may be considered to be guided between two shells, the E region of the ionosphere on the outside and the earth on the inside. The attenuation depends on the resistivity of the shells. This, on account of skin effect, or the diminishing penetration into the layer on these frequencies, increases with increasing frequency; that is, attenuation is proportional to $\sqrt{\nu}$, according to the 'Austin Cohen' law.

We therefore obtain the general fact that only extreme wave lengths, the longest and shortest, are useful for long-distance transmission, and this is the characteristic to which the correct treatment by boundary conditions or phase integrals leads. There is a maximum attenuation in day-time on the broadcast band (500–1,500 kc./sec.) and at such times the propagation is mostly, if not entirely, carried out by the ground ray, and is independent of the ionosphere. At night-time the layer changes; α decreases, and there are reflections from the ionosphere and consequent distortions.

The character of transmission depends on the collision frequency in the E layer, and day-time attenuations are a maximum and ranges a minimum on the broadcast band.

Only a general account of radio propagation has been given. Much remains to be done in explaining the vagaries of the ionosphere, but the general characteristics of long-distance radio communication are now well known.

OBITUARIES

Mr. C. M. Hutchinson, C.I.E.

MR. CLAUD MACKENZIE HUTCHINSON, who died on August 2, at the age of seventy-two, was a pioneer in the field of agricultural bacteriology in India and also contributed notably to a wide variety of problems of tropical soil, fermentation and medical science. He was educated at Glenalmond and St. John's, Cambridge, where he got his 'blue' for golf in 1889–90 and graduated in 1891.

After some years as professor of chemistry at the Colonial College, Hollesley, he joined the scientific staff of the Indian Tea Association in Assam in 1904 and succeeded Dr. Harold H. Mann as scientific officer to the Association in 1907. In 1909 he was appointed Imperial agricultural bacteriologist at Pusa. He retired from the Indian Agricultural Service in 1926 and soon afterwards became chief scientific adviser to Messrs. Imperial Chemical Industries (India), a post he held until he returned to Great Britain in 1931.

Hutchinson's best scientific work was done at Pusa and received official recognition by the C.I.E. conferred on him in 1920. While in Assam he became interested in the cycle of nitrogen in tropical soils and this subject occupied much of his time and thought at Pusa. His publications on the influence of bacteria on soil fertility (1911), on nitrogen fixation in Indian soils (1919), on nitrogenous fertilizers in India (1919), on fermented green manures (1923) and on the conservation of humus in Indian soils (1927) were offshoots from this work but the main part was never published, for a serious illness struck him down a few days after he started to assemble the results on his return from the East. But the work itself had a widely stimulating effect in India: to cite one instance only, it was Hutchinson's studies on the fermenting of green plant residues that led to R. D. Anstead's activated composts, afterwards developed in conjunction with Gilbert Fowler and now attracting so much attention in Great Britain in connexion with the disposal of town waste.

An outstanding work on the bacterial wilt of tobacco, a fascinating study of the rice beer ferment 'bakr', work on the pebrine disease of silkworms, on the bacteriology of indigo manufacture and on indigenous sources of phosphoric acid, the development with W. Hodgkinson of the electrolytic chlorine (E.C.) process of sterilizing water, studies on the micro-anatomy of Cimex for the research workers on kala azar, and on antiseptic measures for use in sugar factories, were some of the other scientific contributions from an astonishingly fertile mind.

This versatility was the keynote of Hutchinson's character. He was an exceptionally gifted photographer and in addition to making the photographic section at Pusa one of the best of its kind, published notes on photographic illustrations and on photomicrography, and prepared a number of cinema films for agricultural propaganda. His advice on the laying down and maintenance of turf for golf courses was much sought. Landscape painting and bridge, at which he was highly proficient, were a solace when illness prevented outdoor activities, as was increasingly the case in recent years. He was an interesting and refreshingly acid conversationalist and debater.

Many friends will mourn a picturesque and stimulating personality. His marriage in 1914 to Alice Muriel, daughter of J. Walter Leather, Imperial agricultural chemist at Pusa, who survives him, was an exceptionally happy one; her untiring care did much to make possible the considerable scientific output he accomplished in spite of persistent illness.

E. J. BUTLER.

Dr. H. R. Spencer

DR. HERBERT RITCHIE SPENCER, the well-known London consultant in obstetrics and gynæcology, who died on August 28, was born at Atherstone in Warwickshire on January 16, 1860. Contrary to what has sometimes been stated, he was no relation of his namesake the famous philosopher. He received his scientific and medical education at University College, London.

Besides numerous contributions to periodical literature on the clinical aspects of his speciality he took a keen interest in its historical side and medical history generally. He played an active part in the Third International Congress of the History of Medicine held in London in 1922, and delivered the Harveian Oration before the Royal College of Physicians on "William Harvey: Obs etric Physician and Gynæcologist" in 1921, the Fitzpatrick Lecture before the same body on "The History of British Midwifery (1650–1800)" in 1927, and the Lloyd Roberts Lecture on "The Renaissance of Midwifery" before the Medical Society of London in 1924. He also read a paper at University College Hospital on "Medicine in the Days of Shakespeare" in 1929. He possessed a remarkable collection of old books connected with his subject, besides being a constant reader in the library of the Royal Society of Medicine and a valuable member of the Library Committees of this Society and of the Royal College of Physicians for many years. He was an accomplished scholar and delighted in translating Horace and Goethe.

Spencer received many distinctions at home and abroad. He was honorary LL.D. of the University of Aberdeen, and in 1923 was president of the Medical Society of London.

J. D. ROLLESTON.

WE regret to announce the following deaths:

Mr. W. H. Caldwell, formerly University lecturer in biology in the University of Cambridge, known for his work on the embryology of the Monotremata and Marsupialia, on August 28, aged eighty-two.

Mr. H. Grindell-Matthews, known for his inventions in the field of radio-telephony, on September 11, aged sixty-one.

Dr. Robert Thomas Hill, geologist of the United States Geological Survey during 1889–1904, aged eighty-three.

NEWS AND VIEWS

Sunspot and Magnetic Storm of September 18–20

THE largest group of sunspots since January 1940 crossed the sun's disk between September 10 and 23. The group was a complex stream of spots some 150,000 miles in length, and its maximum area exceeded 2,000 millionths of the sun's hemisphere, or about 2,300 millions of square miles. At central meridian passage on September 16·8, the centre of the group passed within 4° of the centre of the sun's disk. Thus the earth was in a favourable position to be affected by a corpuscular stream that might be shot out from this disturbed region within a day or two of September 16·8. Statistical data of sunspots and magnetic storms show that out of every ten spot-groups of great size (1,500 millionths of the sun's hemisphere or greater), seven groups are associated near the time of their central meridan passage with a magnetic storm, the mean position of the group at the time of the commencement of the storm being about one day past the central meridian (see the *Observatory*, 62, 319; 1939). A valuable criterion of especially active spot groups is the occurrence of brilliant chromospheric eruptions, or 'solar flares' (*loc. cit.*, p. 321), which may be observed in monochromatic light at certain wavelengths only—the solar spectrum lines generally used being C for visual observations and H and K for photographic records.

In the present case, a brilliant eruption was observed at Greenwich on September 17 at 8½h. U.T., this being associated with an ionospheric irruption (fade-out). About 20 hours later, a magnetic disturbance began; this developed into a great storm which proclaimed itself by disturbance on radio circuits and by displays of the aurora borealis. As recorded at Abinger, a first climax of disturbance was shown by the magnetic traces between 7h. 2m. and 7h. 6m. on September 18, but the maximum of the storm as a whole was reached at about 0h. on September 19. The total ranges recorded throughout were: 120′ in declination, 1,250 γ in horizontal force and more than 1,100 γ in vertical force. This storm is one of the most intense of the present solar cycle, other notable storms being those of January 25–26, 1938, April 16, 1938, March 24–25, 1940, and March 1, 1941. The maximum of sunspot frequency occurred in 1937–38.

Hermann Nothnagel (1841–1905)

PROF. HERMANN NOTHNAGEL, one of the most eminent research workers and clinicians in the second half of the nineteenth century, was born at Alt-Lietzgöriche in Brandenburg on September 28, 1941, the son of a medical man. After holding the chair of pharmacology at Freiburg in 1872 and that of special pathology and therapeutics at Jena in 1874, he was appointed professor of medicine at Vienna in 1883, and held this post until his death. Besides numerous valuable publications on neurology and pharmacology, many of which were translated into English, French, Italian, Portuguese and Polish, he edited a system of special pathology and treatment in twenty-four volumes (1894–1905), to which he contributed a classical monograph on diseases of the intestine and periton um. In conjunction with von Leyden he founded the *Zeitschrift für Klinische Medizin* in 1880, and was the founder and first president of the Vienna Society for Internal Medicine. He died on July 7, 1905.

Grass as Human Food

IN NATURE of July 19, p. 90, this problem was discussed briefly with special reference to an interesting pamphlet "Eating for Victory" by Mr. J. R. B. Branson, and it was pointed out that the main objection to the inclusion of grass in the human diet lies in its high content of cellulose. Mr. Branson has suggested to us that the danger from this source has been unduly emphasized. He recalls that in a paper read before the British Association in 1937, Dr. R. E. Slade stated that the dry matter in the leaf of the grass plant consists largely of soluble carbohydrates and proteins, together with minerals and vitamins, and that it is not until the plant begins to ripen that the carbohydrates change to cellulose and the protein moves from the leaf into the flower and seed. Moreover, according to data provided by Dr. H. E. Woodman, the dry matter of newly grown grass-leaf such as one gets in lawn-mowings, contains as much as 26·5 per cent of protein, 44·5 per cent of carbohydrate and 5·5 per cent of oil, making a total of 76·5 per cent of digestible matter.

The presence of valuable nutrients in young grass will not be denied, but the cellulose content of the remaining 23·5 per cent makes it questionable how much young grass, if indeed any, can be safely eaten over prolonged periods by the average human subject. The physical state of the cellulose, which is in long fibres liable to become bound into large obstructive masses, must be borne in mind. It would seem dangerous, therefore, to advocate the use of grass as an ordinary article of diet without the evidence of extensive scientific experiments as to the amount which can be safely ingested without overloading the excretory powers of the intestines.

Sound Integrating Machine

EXPLORING the sound field around a small source such as a bell or loud-speaker is usually a laborious and time-consuming task because it involves making many measurements in all directions around the radiating source. In the *Bell Laboratories Record* of July it is shown how this effort can be avoided by doing the work automatically with a sound-integrating machine. The apparatus to be tested is rotated on a turn-table while a small condenser microphone, which is mounted on the end of an arm, is swept backwards and forwards over it. This arm is oscillated in a vertical plane through an angle of 180° by a cam which moves it progressively more slowly as it approaches the ends of its excursion, so that equal

radiating areas are traversed in equal times. The output of the microphone is amplified and applied to an analyser to determine the sound intensity in different frequency bands. A meter reading gives the average intensity of the sound in a selected band : and multiplication by a factor, involving the area of a hemisphere the radius of which is the length of microphone arm, gives the total power radiated in that particular band. This integrator measures sound outputs in about one fiftieth of the time previously required to make separate observations at many points about the source. It has been used extensively in developing telephone set housings.

Electrical Demonstration Equipment

IN the *Bell Laboratories Record* of July a description is given by C. D. Hanscom of a variety of equipment which has recently been assembled by the Bell System for use in public lectures. One of the most unusual demonstrations is a Rochelle salt crystal which flashes a neon lamp when hit with a gavel. This illustrates how a change in mechanical dimensions caused by the blow generates momentary voltages of considerable magnitude by the piezoelectric effect. A bar of steel (a permanent magnet) floating in mid-air demonstrates the power of modern magnets. A permanent magnet concealed in the base of the apparatus repels the bar, holding it up against the force of gravity ; a full packet of cigarettes can be supported in addition to the bar. There are also in the collection permalloy rods which are so permeable that they are magnetized by the earth's field, when held pointing north at or near the angle of declination. This is demonstrated by their ability to attract and hold short pieces of permalloy tape.

Decreased size of loading coils, made possible by research on magnetic alloys, is illustrated by a display board on which are mounted a coil with an iron-dust core, a much smaller coil of equal efficiency with a permalloy core, and a still smaller one with the same electrical characteristic, the core of which is molybdenum permalloy. Samples of the 2121-pair cable for exchange areas are included ; also a piece of the Minneapolis-Stevens Point coaxial cable which transmits frequencies of several million vibrations per second. A replica of Bell's original telephone is usually included with the exhibits.

Photography in Stellar Astronomy

A RADIO talk by the late Dr. Annie J. Cannon, entitled "The Story of Starlight", delivered on January 18 last, from Harvard Observatory, appears in the *Telescope* of May–June. A short description is given of the developments in spectroscopy since 1666 when Newton bought a crude prism at a country fair, "to try therewith the phenomena of colour". It is remarkable that two hundred years elapsed before Newton's work was carried to fruition, but when the potentialities in the study of spectra were realized, there was joy in being an astronomer. As Sir William Huggins remarked, "Those were the days when there was something worth while to do in astronomy". Dr. Cannon gives a brief account of photographic developments with special reference to the work of Harvard, where there are half a million negatives, which may be likened to a library of first and only editions, the whole forming the sole record of events observed in the stellar universe during the last half-century. The brief survey includes the important discovery of Miss Leavitt on the relation between the period of pulsation of a Cepheid variable star and its candle-power—a discovery which provides the data for determining the distances of these stars. This radio talk will be read with interest by the amateur astronomer.

Nature Study for Evacuees

THE Universities' Federation for Animal Welfare (U.F.A.W.) has issued two further useful and informative lectures for delivery to evacuee children, namely "British Snakes and Lizards", by Dr. R. C. Blackie, curator of Exeter Museum, and "Frogs and Toads", by E. M. Stevenson, lecturer in biology, University College, Exeter. The lectures are printed as brochures and accompanied by photographic plates for illustration and will help to solve a very pressing problem with many town teachers inexperienced of the countryside where they are now evacuated with their inquiring pupils. In a similar way, the various branches of the Workers' Educational Association have included nature study, biology, botany and kindred subjects in their programme of lecture courses for the coming winter. The West Lancashire and Cheshire Branch of the W.E.A., for example, is arranging nature study courses this winter at the University of Liverpool, Neston Library, Runcorn Technical Institute, Southport Technical Institute and probably Maghull Library, with a special appeal to teachers, and biology classes at the University and some of the branch towns. Attention has been given to nature study at the large Colomendey school camp, North Wales, but in most parts of the country considerable help in this subject is still required by town teachers in care of evacuees but handicapped by the limitations of their own experience of field natural history, which differs so radically from laboratory biology. A "Junior Naturalists' Society" has been formed by F. Stodart at Longfield, Kent, and much help is being given by local branches of the British Empire Naturalists' Association.

Bug Infestation

IN his latest annual report Sir Alexander Macgregor, medical officer of health for Glasgow, states that the total number of houses in that city in which bed bugs were found in 1939 was 309, or 2·1 per cent, as compared with 3·1 per cent in 1938. In 79 houses, or 0·5 per cent only, a "trace" of bed bugs was found, as compared with 0·9 per cent in 1938. In this group only old hatched eggs were found, but no living bugs or eggs were detected in beds or furniture, pictures or household belongings. In 62 houses, or 0·4 per cent compared with 0·5 per cent in 1938, a medium degree of infestation was found, that is, living bugs or eggs were present, but not in the

structure of the house itself. In 168 houses, or 1·2 per cent, a serious degree of infestation was found, living bugs or eggs being present not only in the beds or on furniture but also in the structure of the rooms such as picture rail, skirting and door facings. In the great majority of houses infestation was detected at a fairly early stage by the nurse inspectors. The progress made in the prevention of any infestation during the last six years is shown by a fall from 10·7 per cent in 1934 to 2·1 per cent in 1939 and by a fall of serious infestation from 7·1 to 1·2 per cent during the same period.

Public Health in Mexico

ACCORDING to the *British Medical Journal* of August 9, the National University of Mexico, four years ago, founded its social service system under which every medical graduate is required to practise for five months as a health officer in some part of the country where there is no such representative. He sends in a weekly report of contagious diseases cases seen, and a monthly report which includes information on sanitary questions such as water supply and drainage. Since 1935 more than a hundred graduates have taken part in this social service programme.

Recent Earthquakes

THE provisional epicentres of two earthquakes have recently been found by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association. The first, on June 18, 1941, had its epicentre near lat. 51·5° N., long. 32° W., which is in the North Atlantic Ocean on the ridge which stretches from Greenland to the Azores. Occasional earthquakes are known to occur from time to time on this ridge, showing that it is still one of the unstable regions of the earth. The second shock, on June 26, had its epicentre near lat. 13° N., long. 93° E., which is near the Andaman Islands in the Bay of Bengal.

Sixteen large distant earthquakes were registered on the seismograms at Kew Observatory during August 1941. The greatest was on August 2, when a ground amplitude of 91 μ was attained at Kew, and a full suite of pulses was obtained on August 4, 6, 9, 15 (see NATURE, Sept. 13), 19, and 30. The shock on August 6 at an estimated epicentral distance of 8,800 km. had a probable depth of focus of 200 km. On August 9 there were six shocks, five being from an estimated epicentral distance of 2,030 km.

The Night Sky in October

THE moon is full on Oct. 5d. 8h. 32m. and new on Oct. 27d. 20h. 9m. There will be an occultation of the first magnitude star α Tauri on October 10, the disappearance as seen from Greenwich taking place at 3h. 16·1m. and the reappearance at 4h. 30·1m., the position angles being 290° and 252° respectively. Lunar conjunctions with the planets will be as follows: Mars on Oct. 5d. 23h., Mars 1° S.; Saturn on Oct. 9d. 4h., Saturn 2° N.; Jupiter on Oct. 11d. 4h., Jupiter 5° N.; Venus on Oct. 23d. 17h., Venus 8° S. Mercury is an evening star until Oct. 26 and then becomes a morning star. Venus is an evening star and sets at 18h. 38m. at the beginning and at 18h. 19m. at the end of the month. Mars is a morning star until Oct. 10 when it is in opposition to the sun, and then it is an evening star. At the beginning and end of the month the planet souths at 0h. 41m. and 22h. 6m. respectively. Jupiter is a morning star and crosses the meridian at 4h. 44m. on Oct. 1 and at 2h. 44m. on Oct. 31. Saturn is a morning star, the meridian passages being at 3h. 8m. and 1h. 7.m at the beginning and end of the month respectively. The Orionid meteor shower will commence about Oct. 18 and will continue for a few nights; the radiant point is close to ν Orionis. Comet van Gent (1941d) will be visible with the aid of a small telescope during the month. It will be easily identified, a 3-inch refractor showing it quite distinctly, as its magnitude is about 8·5. The comet is moving northward in declination in the constellation Ursa Major, and on Oct. 19 will be close to ψ Ursæ Majoris. Its distances from the earth and sun in the middle of the month will be nearly the same—about 108 million miles. Although it is receding from the Sun it is still approaching the Earth, for which reason its magnitude will not vary very much during the month, that due to the increase in distance from the Sun being nearly balanced by the change due to the decrease in distance from the Earth. An ephemeris for every four nights is given for the comet. A short ephemeris was given in NATURE of Aug. 2, p. 139.

EPHEMERIS FOR COMET VAN GENT (1941*d*).

1941 U.T.		α	δ	ϱ	r	Mag.
Oct. 1	11h.	25·3m.	+45° 01′			
5		16·0	45 24	1·270	1·050	8·5
9		06·3	45 45			
13	10	55·6	46 06	1·187	1·130	
17		43·9	46 27			
21		30·0	46 48	1·090	1·220	8·3
25		14·3	47 07			
29	9	56·2	47 26	0·993	1·316	

Announcements

DR. W. H. MILLS, F.R.S., emeritus reader in stereochemistry in the University of Cambridge, has been elected president of the Chemical Society until the next annual general meeting.

A meeting to celebrate the tercentenary of the arrival of Comenius in London will be held at the Caxton Hall, London, on September 29. The Archbishop of York will preside, and the principal speakers will be the Prime Minister of the Netherlands and the Foreign Minister of Czechoslovakia. A further meeting will be held at Cambridge on October 24 (see NATURE, Aug. 23, p. 222).

ERRATUM. In the letter entitled "Specific Heat of Supra-Conductive Tantalum" by Dr. K. Mendelssohn in NATURE of September 13, p. 316, the graph as printed is inverted. It should be read as if turned through 180°, without shifting the numerals of the ordinates.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Radiations from Bromine (82)

AN account has recently appeared of some work by J. R. Downing and A. Roberts[1] on the radiations from radioactive bromine, ^{82}Br, of period 34 hours. As their results differ in some important particulars from those I have obtained in a similar series of experiments it seems desirable to mention my results briefly. It was intended to carry out the investigations in some detail, but the work had to be abandoned in the spring of 1940 for more urgent duties, and it seems unlikely that I shall be able to resume it for some time.

The radioactive bromine was prepared by irradiating a thin selenium layer evaporated on gold foil with a beam of 4 Mev. protons from the cyclotron. After the decay of the short-period elements the radiations emitted from ^{82}Br were investigated by means of Geiger-Müller counters in the following methods: absorption of β-rays, absorption of γ-rays, absorption of Compton-electrons produced by γ-rays, β-γ and γ-γ coincidences. The results obtained were as follows.

Absorption of β-rays. At first sight the absorption curve seemed to have a shape similar to the absorption curve of the β-rays from radium E, thus indicating a simple spectrum with a maximum range of about 150 mgm./cm^2. However, a closer analysis revealed a departure from the standard radium E curve near the end of the range of the β-rays. The experimental errors in this region are inevitably large owing to the presence of a strong γ-radiation, nevertheless the results obtained are sufficient to establish the presence of a 'tail', which indicates the existence of a weak group of β-rays of longer range. It seems rather unlikely that this group is due to a contamination, as it decayed with the same period as the main group. Analysis of the logarithmic absorption curve made on the lines of Feather's method[2] shows that the best agreement with the experimental results is attained on the assumption that the β-radiation from ^{82}Br consists of the following two groups:

97 per cent of the disintegrations have an upper energy limit of 460±10 kev.;

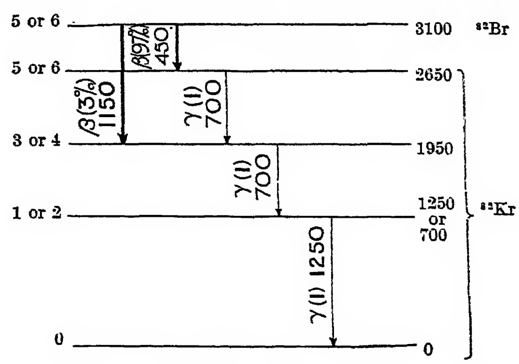
3 per cent of the disintegrations have an upper energy limit of 1,200±50 kev.

Absorption of γ-rays. The absorption of the γ-rays was investigated in lead and aluminium. Here again the absorption curve seemed initially to be a purely exponential one, but on using better geometrical conditions the presence of at least two components was revealed. The best fit with the experimental absorption curve is attained by assuming the existence of two γ-quanta of about 700 and 1,300 kev., the intensity of the former being twice that of the latter.

Absorption of Compton-electrons. The energies of the γ-rays were also investigated by measuring the absorption of the Compton-electrons passing through two counters in a coincidence circuit. The absorption curve showed directly the existence of a γ-ray line of the energy 1,250±50 kev., and the shape of the curve made it clear that yet another component must be present. By comparing that curve with those obtained with sources of thorium (B+C) and radium (B+C) in identical conditions it was found that the energy of the second component is 700±50 kev. After correcting for the efficiency of the counters for γ-rays of different energies, the intensity of the softer γ-quantum was found to be twice that of the harder.

Coincidence measurements. All coincidence measurements were made with counters in a standard position, the efficiencies of which for β- and γ-rays had been previously determined. The ratio of β-γ coincidences to the number of β-rays was found to vary only very slightly with the thickness of absorbers for the β-rays. This result is not in contradiction with the assumed presence of two β-ray groups, since owing to the low intensity of the group of longer range the expected decrease of the coincidence ratio within the whole investigated region (up to 100 mgm./cm^2) is only about 15 per cent, and on the other hand the accuracy of the β-γ coincidence measurements is poor at the end of that region, mainly owing to the large γ-γ coincidence rate. Actually the results indicate a tendency towards a decrease of the relative β-γ coincidence rate, as would be expected from the presence of two β-ray groups; at the same time the results show that even the harder β-ray group is also correlated with a γ-ray emission.

The rate of β-γ coincidences per 1,000 β-rays—with no absorber—is 4·88±0·07. The rate of γ-γ coincidences per 1,000 γ-rays was found to be 3·14±0·07. From these figures we deduce that the γ-rays following the emission of the main group of β-rays form a cascade of 3 quanta per disintegration. The assumption of two 700 kev. quanta and one 1,250 kev. gives also an agreement between the observed rate of β-γ and γ-γ coincidences and the value calculated from the efficiency of the counters for γ-rays of these energies.



All the above results may be expressed in the nuclear level scheme of ^{82}Kr shown in the accompanying illustration, together with the transitions from ^{82}Br. The figures on the right side give the energies

of the states in kev., and on the left side their presumed spins. As seen, the total disintegration energy of ^{82}Br is 3·1 Mev. The assignation of the spin values was based on the absence of direct γ-transitions from the upper levels to the ground-state, and on the small abundance of the more energetic β-ray group. A more definite determination of the spins could not be made without establishing the nature of the γ-transitions.

J. ROTBLAT.

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The University of Liverpool.
Aug. 20.

[1] Downing, J. R., and Roberts, A., *Phys. Rev.*, **59**, 940 (1941).
[2] Feather, N., *Proc. Camb. Phil. Soc.*, **34**, 599 (1938).

Refraction Patterns of the Surfaces of Opaque and Translucent Solids

IN a previous note, one of us (Rivlin[1]) has described a method for studying the distribution of facets of various orientations on the rough surfaces (ground, scratched or etched) of transparent solids.

We have since developed a similar method for studying such surfaces of opaque or translucent solids. This consists in making a cast of the rough surface using some transparent substance and in obtaining the refraction pattern in a manner similar to that previously described.

We have found 'Diakon' a suitable substance for the cast. A solution of 'Diakon' in ethyl acetate is painted on to the rough surface and is allowed to harden. The painting process is repeated until a suitable thickness of 'Diakon', say ½ mm., is obtained. The cast is then peeled from the surface. A point source of light is viewed through the cast and a refraction pattern which is characteristic of the surface under consideration is obtained.

The accompanying figure shows the refraction pattern obtained from a cast of the (100) surface of a hypersthene crystal ground with 60-mesh carborundum abrasive. This indicates strongly preferential fracture of the crystal on planes parallel to the zone axis [001]. The *b* axis of the crystal is horizontal.

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W. A. WOOSTER.

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August 26.

[1] Rivlin, R. S., NATURE, **146**, 806 (1940).

Observational Clue to the Size of Meteors

CONSIDERABLE difference of opinion prevails concerning the size and mass of meteors. While one school of investigators, attacking the problem from theoretical considerations based on certain relations between amount of light emitted by an incandescent body and its extent of surface and mass, is prepared to give the nucleus of average naked-eye meteors a volume scarcely greater than a few cubic millimetres, another school, consisting mainly of experienced observers, but by no means indifferent to theoretical calculations, argues in favour of much larger dimensions for them—at least several cubic inches. As there is no possibility of observing meteors at close quarters, much less handling them, while on their aerial path, the question has remained undecided.

An observational clue, however, is available. Even in strong moonlight, one can often see distinctly meteors of the 2nd and 3rd magnitude. Owing to the illumination of their background, moonlight meteors not only appear to be much nearer objects, marking their trails, not *on* the dark background of the sky, as they usually do in moonless nights, but *in front of* the illuminated background. Occasionally, they send forth a momentary flash (which greatly adds to their brightness), due undoubtedly to the reflexion of moonlight from their surface. For such a thing to happen, not only should the reflecting surface of the meteor be suitably disposed towards the moon, but also it should have an appreciable area also.

Having observed the phenomenon a number of times quite distinctly, I believe that it furnishes observational evidence in favour of the relative large size of meteors.

MOHD. A. R. KHAN.

Begumpet,
Deccan.

Ionization Potentials of Polyatomic Molecules

THE recent development of our knowledge of the electronic structures of molecules makes it possible to specify with reasonable certainty the particular electron with which a definite molecular ionization potential is to be associated. In an organic molecule the variation of an ionization potential with, for example, alkyl or halogen substitution reflects the change in negative charge density in that part of the molecule in which the electron is located. The existence of resonance in a molecule also considerably affects the ionization potentials of the resonating electrons. It is clear, too, that ionization potentials are intimately bound up with chemical activity, dipole moments, refractivities, combination radii, electronegativities, etc.

In a programme concerned with the determination of molecular ionization potentials we have used absorption spectra in the vacuum ultra-violet whenever the absorption bands obtained were sufficiently discrete for the photo-ionization limit to be observed. When this was not the case electron impact methods were employed, the values being substantiated by whatever limited spectroscopic evidence was available. The spectroscopic values are accurate to at least 0·01 v., while the electron impact ones have the lower accuracy of about 0·1 v. Higher ionization potentials than the minimum have in general been obtained only by the electron impact method and are of a somewhat lower accuracy. Some of the values so far derived for the *first* ionization potentials

of certain classes of molecules are collected below:
H_2O, 12·56; CH_3OH, 10·8; C_2H_5OH, 10·7; C_3H_7OH, 10·7; $(CH_3)_2O$, 10·5; $(C_2H_5)O$, 10·2; H_2S, 10·42; C_2H_5SH, 9·7; $(CH_3)_2S$, 9·4; $(C_2H_5)_2S$, 9·3; $n(C_3H_7)_2S$, 9·2;
NH_3, 10·8; CH_3NH_2, 9·8; $(CH_3)_2NH$, 9·6; $(CH_3)_3N$, 9·4;
H_2CO, 10·83; CH_3CHO, 10·181; $(CH_3)_2CO$, 10·1; CH_2CHCHO, 10·06;
$CH_3CHCHCHO$, 10·19;
CH_3CCH, 11·25; $HCCCCH$, 10·74;
H_2CCHCl, 9·95; $ClHCCHCl$, 9·61 (*cis*), 9·91 (*trans*); C_6H_6, 9·19; $C_{12}H_{10}$, 8·3; $C_6H_5CH_3$, 8·77; $C_6H_4(CH_3)_2$ (*o*, *m* and *p*), $\sim$ 8·3 electron volts.

Values given to 0·01 v. are spectroscopic, the others are electron impact values. For H_2O, H_2S, H_2CO and their alkyl derivatives the electron removed is a non-bonding $p\pi$ oxygen (or sulphur) electron. For NH_3 and the amines the minimum ionization potential corresponds to a $2p_z$(n) electron, which is non-bonding with orbital perpendicular, to HHH plane[1]. In methyl acetylene, diacetylene, the halogenated ethylenes and the aromatic molecules, π electrons of the double and triple bonds are involved, these being modified by resonance in molecules where conjugation occurs.

For acetaldehyde, acrolein and crotonaldehyde, very extensive Rydberg series were found in the vacuum ultra-violet, enabling the ionization potentials of these molecules to be obtained with unprecedented accuracy. One of the Rydberg series found for acetaldehyde contained sixteen members and gave a limit corresponding to $10{\cdot}1811 \pm 0{\cdot}0007$ v. This is the most accurate ionization potential so far determined for a polyatomic molecule. A fifteen membered series was obtained for crotonaldehyde giving an ionization potential of $10{\cdot}187 \pm 0{\cdot}001$ v. and a series of ten members in acrolein converging to a limit of $10{\cdot}057 \pm 0{\cdot}006$ v.

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[1] R. S. Mulliken, *J. Chem. Phys.*, 3, 506–14 (1935).

Carotenoids of Grass Silage

WHEN using Moon's[1] method for the estimation of 'crude carotene' in routine silage samples, we have applied Moore's[2] chromatographic technique for removing other chromogens from the carotene solution, as obtained by Moon's method, in order to obtain a value for 'pure carotene'. In the case of silages the 'pure carotene' values may be considerably less than the 'crude carotene' values.

Latterly we have sought to replace the customary phase separation of 'crude carotene' and xanthophylls by using the same chromatographic technique for the removal of xanthophylls as well as of non-carotene chromogens from the petrol ether solution.

Values for 'pure carotene' obtained by (*a*) passing the petrol ether solution of 'crude carotene' after phase separation of xanthophylls through a column of dicalcic phosphate (prepared as recommended by Moore[2]) and by (*b*) passing the original petrol ether solution of total carotenoids through a similar column were in close agreement. For routine carotene estimations on silage, procedure (*b*) has the advantage of avoiding the phase separation.

The chromatograms of a series of samples of laboratory grassland silage examined in this way displayed an interesting feature. From the fourth day after ensiling, a well-defined blue-green band about 1 mm. wide appeared some 5 mm. *below* the strongly adsorbed 'xanthophyll' band at the top of the column. While attempting to repeat this observation on later samples, this band was not always obtained at once, but a light yellow band of the same thickness appeared in the same position on the column. On sucking off the petrol ether from the column this yellow band changed in the course of 3–5 hours to the same blue-green as originally observed.

This ready isolation of a blue-green chromogen from the petrol ether solution of the carotenoids of grassland silage may have a bearing on the production of 'grass yolks' in eggs from hens fed on silage[3].

A seasonal incidence of olive-tinted yolks has also been observed in egg-packing stations in Northern Ireland. In one case it was found that the birds were ranging on young pasture rich in suckling clover; the incidence of the olive tint was cured by shutting the birds off from pasture for a time.

It seems possible that the cause of this seasonal incidence of olive-tinted yolks may lie in the special richness of early summer pasture in carotenoids, together with factors increasing the lability of the carotenoids and favouring the production of carotenoid derivatives of blue or blue-green colour. One such factor might be acidity, present alike in grass silage and in the fowl's crop.

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Aug. 20.

[1] Moon, F. E., *J. Agric. Sci.*, 29, 295 (1939).
[2] Moore, L. A., *Ind. Eng. Chem.*, Anal. Ed., 12, 726 (1940).
[3] Gish, C. L., Payne, L. F., and Peterson, W. J., *Poultry Sci.*, 19, 154 (1940).

Polygenic Variability in Wild *Drosophila melanogaster*

SEVERAL authors have reported the recovery of variant types by inbreeding *Drosophila melanogaster* caught in the wild. The mutations described have generally been of single major genes, recognized either by their obvious morphological or lethal effects; inverted sections of the chromosomes have also been found. The literature of the subject has been reviewed by Dobzhansky[1].

Adaptation and speciation, however, chiefly depend on the action of selection upon what has been called quantitative, or more recently polygenic, variation[2]. Many genes, each having a small effect, control this type of variation, which probably affects all characters showing a range of apparently continuous variation. Such polygenic variation has now been shown to exist in wild populations of *D. melanogaster*.

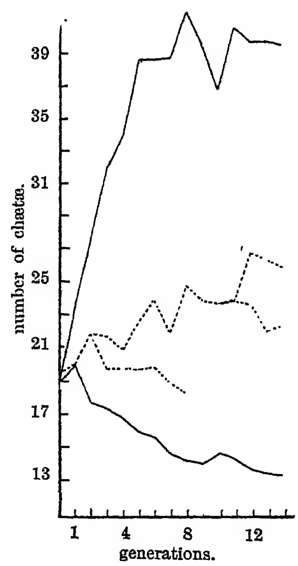
Flies were trapped in various parts of southern England in the summer of 1940. Two strains derived from flies caught at Ockley and Ealing respectively were subjected to selection for increase and decrease of the number of chætæ in the sternopleural regions. Dubinin and collaborators[3] have shown that populations from different parts of the U.S.S.R. have characteristic and different numbers of sternopleural chætæ, and my own experiments (unpublished) have shown the variation to be polygenic.

Before selection the two strains had a mean number of sternopleural chætæ within the range of variation found in laboratory stocks and flies collected from other localities. The Ockley strain had a mean of 19·05, a variance of 5·1552 and a range from 24 to 16 in a rather crowded culture; the Ealing strain a mean of 19·65, a variance of 2·3346 and a range from 25 to 15.

The results of selection are shown in the accompanying graph, in which the mean of the two sex-means is plotted against the filial generations. The Ockley strain (solid line) was selected in the first and following generations of the experiment. The line selected for increased number shows a remarkably rapid advance for five generations, during which the number of chætæ was doubled; from the fifth to the fourteenth generation no further advance occurred. The line selected for decreased number shows a slower but continuous advance after the first generation under the influence of selection, which appears to be still operative in the fourteenth generation.

The Ealing strain (broken line) was mated at random in the first two generations of the experiment, during which the number of chætæ increased slightly; selection in both directions was begun in the third generation. The high selection line shows an irregular advance which has not ended by the fourteenth generation. The low selection line returns to the parental level, where it remains stable for three generations. A decrease then begins which is ended by the death of this selection line. A second low selection line was started in the tenth generation by back selection from the high line; this led to a reduction of chæta number after the first generation of back selection. Thus after eight generations of selection sufficient variability was still present to permit not only of new increases, but also of decreases in chæta number when the direction of selection was reversed.

Both the wild strains selected possess a store of polygenic variability; in one, the Ockley strain, this was readily available to the action of selection, especially in the direction of increased number, giving an advance far greater and more rapid than



——— Ockley strain
· · · · · Ealing strain
mean of ♂ and ♀ means.

has been obtained by selecting the progeny of crosses between laboratory stocks. In the Ealing strain the variability was more gradually released, so that selection was still operative after twelve generations. Such a liberation of stored variability is brought about by the recombination of internally balanced combinations of + and − polygenes[2].

The genes available for selection were not alike in the two strains; those in the Ockley strain increased the number of dorsocentral and scutellar bristles as well as the sternopleural chætæ on the number of which selection was carried out (the low selection line, however, showed the normal number of four dorsocentral and scutellar bristles). In the Ealing strain no change was observed in the number of dorsocentral or scutellar bristles.

Polygenic variability has previously been demonstrated only in laboratory stocks and domesticated plants and animals, although its existence in wild populations has been deduced from the behaviour of interspecific and inter-racial hybrids. It is now shown to exist within wild populations of *D. melanogaster*.

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London, S.W.19.
August 7.

[1] Dobzhansky, Th., *Biol. Rev.*, **14**, 339 (1939).
[2] Mather, K., *J. Genet.*, **41**, 59 (1941).
[3] Dubinin, N.P., and collaborators, *Biol. Zhurn.*, **3**, 166 (1934).

Importance of Adult Education

I READ many articles concerning after-the-War problems, but all are vague and not wholly convincing. At one time we had here in Colorado a Populist Party. It was a party of protests and for a time prospered, but it withered away because it had no adequate programme. Some wit wrote: "A Populist is a man who doesn't know what he wants, but wants it damned bad."

It seems to me that the first step towards a reasonable programme is to define our objectives. Let us begin with these: (1) every man his job; (2) an adequate standard of living.

We then proceed to ways and means. Universal employment implies universal capacity to render service, excluding only the unemployable, who have to be segregated in institutions, and many of these can undertake simple types of work. The ability to do useful work requires suitable and varied education. This education must have moral and cultural aspects, developing social conscience and breadth of view as well as technical skill. The work must be done for use, not primarily for profit, but there must be material rewards.

The standard of living depends especially on two things: (1) ability to produce; (2) ability to use.

The facilities for production have increased so greatly in recent years, that I have not met a man who does not believe that poverty could be abolished. Ability to use depends largely on education and social contacts. Thus the lovely English countryside is capable of affording enjoyment to thousands who at present regard it with indifference, and with no extra cost to any one, except perhaps facilities for getting about (when young, I used to go on foot, with a pack on my back). The libraries offer us untold wealth, if we care to use it. Thus the standard of living depends very largely on the standard of life.

At the same time we must recognize the fact that in recent years not only has the production of wealth greatly increased, but also this wealth has reached the people, and represents a triumph of democratic economy. The New York *Sun* recently offered some statistics, of which I quote a part: In 1900 there were in the United States about 1,000,000 telephones; now there are 20,400,000. In 1900 there were 8,000 automobiles; in 1941 there are 25,000,000. In 1920 there were only 1,000 radio sets; in 1941 there are 43,000,000. In 1910 there were 16,372,000 savings accounts; in 1941 there are 46,000,000.

These gains are enormous, yet not without their disadvantages. In the United States nearly a hundred thousand persons die from accidents each year, a large proportion due to incompetent handling of automobiles. The radio brings us wisdom, but more trash. Thus we have to learn to enjoy and profit by our blessings, avoiding their misuse. Here we have a clearly defined programme, and we can carry it forward without waiting for the end of the War. Among reasonable people it should meet with no hostility, but it does imply willingness to co-operate, and a certain degree of courage and faith. I can believe that very many of those who are now our enemies would be glad to join with us in the endeavour, once they are convinced that we are sincere and unafraid.

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A Scientific Press Bureau

THE second editorial article in NATURE of August 30, "Physics and the Future", remarks how remote is science to the majority of citizens. As never before, pure and applied science to-day plays an essential part in affairs, and it has recently been said that scientific development can make good in a very short time the material wastage and set-backs of this War. But it is only occasionally, as when 'Radiolocation' was announced, that the average citizen realizes that science is not entirely a means of producing more and more terrible weapons of destruction. The scientific attitude applied to our post-war problems, we believe, can rid civilization of recurrent wars and economic chaos. If we admit the ideal of democracy, the power of science to accomplish these ends must depend upon the public acceptance of science as a desirable thing.

Now how does the average citizen learn of the work of science? We find in the *Manchester Guardian* and *The Times* excellent accounts of new developments, but the mass-circulation newspapers almost without exception ignore scientific news but for occasional garbled items of a sensational nature, or comic strips of the "Buck Ryan and his Space Ship" type.

In the United States, newspaper readers are better served. Natural science editors contribute special and weekly articles in most of the large papers, and Science Service, directed by Watson Davis, publishes the weekly "Science News-Letter" which is frequently quoted by the Press.

While planning for the future, the representatives of science in Great Britain must admit the question of public relations in the post-war period, otherwise science may not attain the recognition necessary for it to contribute fully towards a better world. Instead, antagonism might grow up among those who know only of the inventions that have been misapplied in war and in commercial exploitation.

What is required now is a 'set of blue-prints' for a future Scientific Press Bureau, supported by the scientific societies and engineering institutions and staffed by experienced journalists. Bold in conception and vigorous in its policy, it must bring to the man in the street, through his newspaper, accurate and balanced knowledge of the work, aims and achievements of science and the technical arts.

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Herts. Aug. 31.

Plankton as a Source of Food

IN reply to the latest communication under this heading[1], I would like briefly to recall (*a*) the common agricultural practice of green manuring[2] in which often the only obvious addition to the land is of 'carbon'[3] though the benefit to future crops is undeniable[4], (*b*) the importance of freshwater algæ as soil surface-binders[5] even if the addition of potential humus is small, (*c*) the facts that many algæ are notoriously rich in vitamins[6] and are now known to contain growth-substances[7] in such amounts as might conceivably be absorbed from the soil by seeds[8] and roots[9] and have a formative and growth-promoting action upon various organs of vegetable plants[10], (*d*) that the exact manurial and other treatment can further condition the vitamin content and growth and robustness of a crop for reasons not yet understood[4], (*e*) the ubiquity and usual wastage of the human system as a source of combined nitrogen and phosphorus as well as of auxins[10], and (*f*) that Cyanophyceæ capable of fixing nitrogen can be grown in mineral solutions as well as on or near the surface of soil[11], while the presence of other algæ increases nitrogen-fixation by bacteria[5]; on the other hand it is often wasteful and may be harmful to add nitrates and ammonium salts to soils that have to be watered[12].

In my previous communication[13] I did not, nor do I now, contend that any (or even several together, so far as they are applicable) of these or related matters that may be concerned with plant nutrition via watering will actually benefit the growth and production of vegetable crops to an appreciable degree; my object was merely to suggest a mode of practical application after pointing out such a possibility, which, I maintain, should be fully investigated by means of controlled field experiments in proper bulk.

NICHOLAS POLUNIN.

Department of Botany,
University of Oxford.
Sept. 13.

[1] NATURE, 148, 314 (September 13, 1941).
[2] Imperial Bureau of Soil Science, Technical Communication No. 22.
[3] Russell, "Soil Conditions and Plant Growth", 7th ed., London (1937).
[4] Jenkins, "Organic Manures", Imperial Bureau of Soil Science, Technical Communication No. 33 (1935).
[5] Fritsch, "The Rôle of the Terrestrial Alga in Nature", Essays in Geobotany . . ., 195, California (1936).
[6] Tilden, "The Algæ and their Life Relations", London (1935).
[7] van Overbeek, *Bot. Gaz.*, 101, 940 (1940).
[8] Croxall and Ogilvie, *J. Pomol. and Hort. Sci.*, 17, 362 (1940).
[9] Hitchcock and Zimmerman, *Contrib. Boyce Thompson Inst.*, 7, 447 (1935); Pfahler, *Jahrb. wiss. Bot.*, 86, 675 (1938).
[10] Went and Thimann, "Phytohormones", New York (1937); Meyer and Anderson, "Plant Physiology", London (1940).
[11] NATURE, 142, 878 (1938).
[12] Barker, "The Use of Fertilizers", London (1935).
[13] NATURE, 148, 143 (1941).

DRY FUEL FORESTS OF THE MADRAS PROVINCE

A SMALL illustrated monograph written by Mr. A. L. Griffith, I.F.S.* provincial sylviculturist, Madras, merits the close attention of the administrative and forest officers in West and East Africa.

A century ago in the 1830's and 1840's Madras was passing through some regrettable and painful forestry experiences. The administration for four decades had had no belief in the necessity of a forest policy or in forest protection; and the people naturally wanted neither. Whilst, therefore, during the first half of the nineteenth century the finest teak forests or the most accessible at that time were despoiled, the larger areas of forest situated in the central and eastern regions—what are termed here the dry fuel forests (savannah or bush in Africa)—were regarded as of no value and the population allowed to cut, burn and overgraze them, as in the past. Even when the Government realized that some form of protection should be given these areas, they were not regarded as 'forests' or placed under the then existing Forest Department. The idea grew and persisted that the work of the forest officer should be confined to the management of marketable timber forests only—an idea which has resulted in irretrievable harm to much forest and has caused the disappearance of large areas both of 'timber forest' and 'dry fuel' or 'bush' forests. Mr. Griffith writes: "The dry fuel forests of the unreserved, waste lands and panchayat forest" (in which the administration at one period placed such a childish faith) "have either completely disappeared or are very rapidly disappearing due to the ravages of man and his animals, chiefly goats." Some of Mr. Griffith's predecessors were writing nearly identical words almost exactly a century ago; the country, be it remembered, being at that period much less developed and the population and their animals very much less numerous.

At the present day we are told that the dry fuel forests of Madras are one of the most important types occurring in the Province, and in reserved forest alone they consist of roughly 900,000 acres with an annual cut of approximately 30,000 acres which produces an annual revenue of Rs.400,000. This type, says the author, occurs in twenty-two out of twenty-eight districts, and the general climate has an average rainfall of from 10 to 35 in., most of this precipitation coming from the north-east monsoon in October and November. Apart from this rainy period the rest of the year is generally very dry and very hot. These forests are essentially 'local' forests, and supply the needs of the local villages with fuel, agricultural implements, small building timber, grazing, etc.

What is the difference between this 'type' and that of the large areas of so-called savannah or bush in Africa, upon which the people equally depend in one way or another for the chief ingredients of existence? Yet in Africa, by many of the administration at least —and probably not a few forest officers (all brought up in the belief)—savannah or bush was until quite recently not regarded as forest or as meriting or requiring any attention. That the recognition of the value of the type took upwards of a century in Madras is surely no reason for wasting so long a period and making the same mistakes in Africa. The following brief extract from the monograph, which must be read to be fully appreciated, may be considered:—

"These areas which are in the reserved forests are worked in general on a thirty-year rotation, now in many cases being raised to forty years, by the system of simple coppice. At each coppicing the mortality of stools is 5–10 per cent and this is not being replaced by natural regeneration.

"*Hence the improvement and maintenance of these forests by artificial regeneration is an absolute necessity*" (italics are the author's).

During the past ten years it has been shown that this artificial regeneration can be done with a certainty of success and at a reasonable cost even under the poorest conditions by the 'rab' method, and at practically no cost at all by the '*rab-kumri*' method, that is in conjunction with field crops (shifting cultivation).

* "Note on the Artificial Regeneration of the Dry Fuel Forests of the Madras Province" (*Ind. For. Rec.*, Silvic. (New Series), 3, No. 8. New Delhi, Govt. of India Press: 1940).

STEAM HEATING OF BUILDINGS

SO long ago as 1653, Sir Hugh Plat, of London, heated glasshouses with steam from a cast-iron pot placed outside. This is described in his book on horticulture, "The Garden of Eden". James Watt is believed to have used in 1784 the first elementary steam radiator. It was fitted in his study and consisted of an iron box with connecting pipes through which steam was passed from boilers. In 1825, Matthew Murray, of Leeds, the well-known competitor of James Watt, heated his house, which was locally known as "Steam Hall", by means of exhaust steam from the engine of his adjoining works. Meanwhile, in 1804, Oliver Evans in the United States had mentioned in one of his patents the use of exhaust steam from engines for heating.

An interesting article by David Brownlie, which deals specially with steam heating in the United States, begins in *Engineering* of September 5. He points out that from the technical and scientific point of view, one of the most serious defects of modern civilization lies in the fact that the condensing steam engine and turbine still lose some 55 per cent of the total heat in the coal, or other fuel, in the condenser. Even more serious is the use of the non-condensing engine, of which a particularly bad example is the steam locomotive operating at a thermal efficiency of no more than 6–8 per cent. Now experience with thousands of plants, mostly relatively small, has shown that great economy in fuel can be obtained by employing back-pressure or pass-out engines and turbines and utilizing the exhaust steam for heating and process work. The actual thermal

efficiency under average conditions is thus raised to 65—75 per cent by the reduction or elimination of the loss of latent heat.

The exhaust steam can be used directly in individual establishments or by what is popularly termed 'district heating' In general this means the supply of steam or hot water by means of long-distance pipe lines for the heating and general service of all types of buildings extending over a whole district or part of the area of a town.

The re-organization and improvement of the whole fuel system of Great Britain is long overdue, and one of the most important requirements is an extensive development of district heating. To indicate the possibilities in this direction the author first discusses the two chief countries in which district-heating is employed, namely the United States and the U.S.S.R. An important point, the significance of which has not yet been generally realized, is that most of the heating in the United States and all other countries except the U.S.S.R. is carried out on thermally inefficient lines by live steam, and not by the exhaust steam, so that the total power generated in the heating stations is very small. Russia is the only country that has developed district heating upon an extensive scale by using exhaust steam from public supply electric power stations.

In the United States there are at the present time about 175 district heating companies in operation, probably supplying more than 35,000 million pounds of steam per annum. This represents only a small proportion of the total heat used in the domestic field, which requires more than 100 million tons of coal (anthracite and bituminous) per annum in addition to large amounts of oil, natural gas, coke and other fuels. District heating was made a commercial success in 1877, at his house in Chestnut Avenue, Lockport, New York, by Birdsill Holly, who founded the first steam heating company, known as the Holly Steam Combination.

The largest district heating system in the United States at present is that of the New York Steam Corporation. In 1882 the first heating station was put into service at Cortlandt Street in the Broadway area, supplying steam at 80 lb. pressure through three miles of mains. The present total length is equivalent to about ninety miles of 12 in. pipe. It has five heating stations all operated on modern steam-driven power-station lines, the largest being the Kips Bay plant at 35th Street on the East River. The pulverized-fuel equipment for the five boilers at Kips Bay consists of seven mills in an adjoining building with a total duty of 160 tons of bituminous coal an hour. An important feature of the equipment is the softening plant dealing with New York town water.

The ninety miles of mains interconnecting the five stations are of lap-welded steel with welded flanges and corrugated copper expansion joints, and numerous draining stations, capable of operating, if necessary, at 250 lb. per sq. in. pressure. Most of the insulation is 85 per cent magnesia, in blocks 2 in. thick, with canvas and tarred felt outer covering. The mains are generally laid below the pavements in concrete and tile conduits with cast iron covers, the space between the mains and walls and floor of the conduit being filled with loose slag wool.

ANTARCTIC DISCOVERIES

By Prof. R. N. Rudmose Brown

Some preliminary accounts of the important discoveries of the United States Antarctic Expedition, 1939–41, under Rear-Admiral R. E. Byrd, are published in the *Geographical Review* of July, in an article by Lieut.-Commander R. A. J. English, U.S.N. The vessels of the expedition, *North Star* and *Bear*, reached the Bay of Whales on the Ross Ice Barrier on January 11, 1940. A base to accommodate thirty-seven men was set up on the barrier within a few miles of Admiral Byrd's old base of Little America. The *North Star* then left to establish the east base for sixteen men in Marguerite Bay on the west coast of southern Graham Land. There she was joined by the *Bear* and when the unloading was completed the two vessels left for the United States not to return until the early months of 1941, when both bases were evacuated and the whole expedition left for home.

The year in the Antarctic was well used in sledge journeys and in flights. Between Charcot Island on the east and the Ruppert Coast of Marie Byrd Land there was a gap in the known coast-line of Antarctica extending over some seventy degrees of longitude. To the south of the unknown coast-line Ellsworth had established continuity of ice-covered land with many peaks in his trans-antarctic flight of 1935. Light was thrown on this problem by flights from the *Bear* on her journey from the Bay of Whales to Graham Land, which was approximately along the parallel of 70° S. There were several short but important flights. A flight along the Ruppert Coast to about long. 135° W. revealed a coastal range about 4,000 ft. in height, snow-covered but with rock exposures near the coast. Far to the south the peaks of other ranges were seen. From lat. 70° 58′ S., long. 105° 33′ W. a flight southward again revealed such ranges lying parallel to the coast. Lastly, a flight from lat. 70° 4′ S., long. 95° 19′ W. confirmed the impression of the last flight of a mountainous peninsula immediately to the west, and the main coast-line was found to extend eastward in about lat. 73° S. These flights have thus filled in the coast-line south of the Pacific except for a stretch of some three hundred miles between long. 115° and 122° W.

The general arrangement of the mountains in this section of Antarctica would appear to be a series of ranges more or less parallel with the coast. The Rockefeller Mountains seem to be the western end of a long range broken by many glaciers pouring northward from the high plateau of Marie Byrd Land. The highest peak discovered was Mount Hal Flood, over 10,000 ft. in altitude, in lat. 76° 4′ S., long. 135° 50′ W. Farther eastward there were sighted bare coastal mountains towards which the interior plateau fell. These coastal mountains extended at least as far as long. 133° W. They suggest

a continuation of the Andean folds of Graham Land. Incidentally also later flights supplemented Rymill's charting of Alexander I Island by adding the southern coast-line. This was determined in flights from the east base. Another of these flights mapped the western end of King George the Sixth Sound, which was also examined by one of the numerous sledge expeditions from the same base.

Some new facts in regard to the Ross Barrier seem to have been discovered. A flight from the base to lat. 81° 8′ S., long. 176° 15′ W. showed wide fractures in three places, not yet specified, which suggests that the ice was aground. A large snow-covered island, about thirty miles long, was noted south-east of Roosevelt Island in approximately lat. 81° S., long. 158° W. This, of course, would mark a land area overlain by the shelf-ice of the Barrier.

A flight was made along the northern face of the Queen Maud Range from Mount Hope near the Beardmore Glacier to long. 147° W. In long. 175° W. a mighty glacier nearly as large as the Beardmore Glacier was noted.

Perhaps, however, the most important result of all was achieved from the east base in a flight southward and then south-eastward across the Eternity Range of southern Graham Land to the missing western coast of the Weddell Sea. This coast has proved unapproachable by sea. Larsen, Bruce, Filchner and Shackleton each were foiled by heavy packs in attempts to penetrate the western part of the Weddell Sea and between lat. 71° S. and the Weddell or Filchner Barrier in lat. 77° to 78° S. nothing was known. The Eternity Range was photographed and followed southward to lat. 74° 37′ S., long. 61° 15′ W. Beyond this as far as lat. 77° S. a south trending coastal range was visible with summits of apparently decreasing altitude. These discoveries suggest that the Weddell Sea may be wider at its southern end than had been believed. From both the west and east bases further work was done by plane and sledge, and extensive photographic surveys were made especially in Marie Byrd Land. Other aspects of the work of this highly successful expedition are not available. The article in the *Geographical Review* includes a preliminary small-scale map.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

DIRECTOR OF EDUCATION—The Town Clerk, Belfast (endorsed 'Director of Education') (October 3).

SPEECH THERAPIST—The Director of Education, Leopold Street, Sheffield (October 6).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING—The Registrar, University College, Nottingham (October 6).

DEMONSTRATOR IN ZOOLOGY—Acting Head of the Department of Zoology, the University, Edgbaston, Birmingham 15 (October 7).

LECTURER IN ELECTRICAL ENGINEERING SUBJECTS—The Director of Education, City Hall, Cardiff (October 8).

INSPECTOR OF SCHOOLS (WOMAN)—The Director of Education, Guildhall, Hull (October 18).

HEAD OF PHYSIOLOGY DEPARTMENT—The Secretary, The Rowett Research Institute, Bucksburn, Aberdeenshire (October 31).

LECTURER WITH QUALIFICATIONS IN MATHEMATICS, PHYSICS OR ENGINEERING—The Principal, Technical College, Kendrick Hall, Stroud, Glos.

DEMONSTRATOR FOR THE BIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science (University of London), c/o University College, Leicester.

SENIOR MATHEMATICAL MASTER—The Principal, King William's College, Isle of Man.

ASSISTANT ELECTRICAL ENGINEER for the Federated Malay States Government Electrical Department—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9769).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Institute: Plant and Animal Products Department. War-Time Drug Supplies and Empire Production. By Dr. M. Ashby. Pp. 39. (London: Imperial Institute.) 1s. net. [99

Other Countries

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1940. Von E. Rübel und W. Lüdi. Pp. 84. (Zürich: Geobotanische Forschungsinstitut Rübel.) [29

Proceedings of the American Philosophical Society. Vol. 84, No. 4: Symposium on Recent Advances in Psychology; Papers read before the American Philosophical Society Annual General Meeting, April 25, 1941. Pp. iii+461-564. (Philadelphia: American Philosophical Society.) 75 cents. [29

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 872: Surface Water Supply of the United States, 1939. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. ix+388+1 plate. 40 cents. Water-Supply Paper 874: Surface Water Supply of the United States, 1939. Part 4: St. Lawrence River Basin. Pp. vi+213+1 plate. 30 cents. Water-Supply Paper 876: Surface Water Supply of the United States, 1939. Part 6: Missouri River Basin. Pp. xi+506+1 plate. 65 cents. Water-Supply Paper 877: Surface Water Supply of the United States, 1939. Part 7: Lower Mississippi River Basin. Pp. vii+379+1 plate. 45 cents. Water-Supply Paper 878: Surface Water Supply of the United States, 1939. Part 8: Western Gulf of Mexico Basins. Pp. ix+393+1 plate. 40 cents. (Washington, D.C.: Government Printing Office.) [29

Ceylon. Part 4: Education, Science and Art (F). Administration Report of the Director of the Colombo Museum for 1940. By P. E. P. Deraniyagala. Pp. F4. (Colombo: Government Record Office.) 10 cents. [29

The Bankruptcy of this Scientific Age. With an Appendix: A Critical Study of the Classical Theory of Evolution. By Prof. Alfred F. Barker. Pp. iii+60. (Melbourne: John Savage and Sons Pty., Ltd.) [39

Indian Central Jute Committee. Economic Research Bulletin No. 1: World Consumption of Jute, 1938–39 and 1939–40. Pp. 17. (Calcutta: Indian Central Jute Committee.) 1 rupee; 1s. 6d. [39

Records of the Geological Survey of India. Vol. 75, Professional Paper No. 10: The Action of Solvents on Two Indian Coals. By R. K. Dutta Roy. Pp. 18. (Calcutta: Geological Survey of India.) 5 annas; 6d. [39

Bulletin of the Auckland Institute and Museum. No. 1: The Moa, a Study of the Dinornithiformes. By Gilbert Archey. Pp. 145 (15 plates). (Auckland: Auckland Institute and Museum.) [39

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Nigeria. Annual Report on the Forest Administration of Nigeria for the Year 1940. Pp. 16. (Lagos: Government Printer; London: Crown Agents for the Colonies.) 1s. [99

Field Museum of Natural History. Report Series, Vol. 12, No. 2: Annual Report of the Director to the Board of Trustees for the Year 1940. (Publication 497.) Pp. 177–330+plates 13–22. (Chicago: Field Museum of Natural History.) [99

Science Reports of the Tokyo Bunrika Daigaku, Section B. Nos. 70–71: On the *Dacrymyces*-Group (Fungorum Ordinis Tremallalium Studia Monographica, III), by Yosio Kobayasi; Über die Wirkung des Saponins auf die *Spirogyra*-Zellen, von G. Yamaba und Z. Araki. Pp. 105–138+3 plates. 60 sen. No. 74: On the Genera Femsjonia, Guepinia and Calocera from Japan (Fungorum Ordinis Tremallalium Studia Monographica, IV). By Y. Kobayasi. Pp. 215–228+2 plates. 35 sen. No. 76: Studies on Japanese Aquatic Fungi, 2: The Blastocladiaceæ. By H. Indoh. Pp. 237–284. 80 sen. Nos. 79–80: Physiological Studies on Laminarin and Mannitol of Brown Algæ, 2: The Seasonal Variation of their Content in *Eisenia bicyclis*, by K. Nisizawa; Physiological Studies on Laminarin and Mannitol of Brown Algæ, 3: Variation of their Content in *Eisenia bicyclis* through various Stages of Growth, by K. Nisizawa. Pp. 9–20. 20 sen. No. 84: The Genus Cordyceps and its Allies. By Y. Kobayasi. Pp. 53–260. 3.20 yen. (Tokyo: Tokyo Bunrika Daigaku.) [99

Dominion Observatory Bulletin No. S-61: Measurement of Earthquake Intensity. By R. C. Hayes. Pp. 201B–204B. (Wellington: Government Printer.) [99

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THE CHARTER OF SCIENTIFIC FELLOWSHIP

IN the conflict of ideas, the clash of two diametrically opposed ways of living, which are involved in the present War, the British Association's recent Conference on Science and World Order may well prove to have as profound a significance as President Roosevelt's clear enunciation of the four freedoms which are at stake, and as the declaration which arose out of his Atlantic meeting with Mr. Churchill. In place of the thoughtless blaming of science for the misuse of the knowledge and power with which scientific discoveries and their application have endowed mankind, we have the recognition that from henceforth science and statecraft, in Mr. Eden's words (see p. 403), must march together.

Nor is this all. The very holding of such a meeting in war-time, a meeting as truly international as the meeting of the Inter-Allied Council held also in London in the same week, attests the existence of the goodwill and faith in international co-operation required to lay the foundations of a better world. The merest glance at the programme of the Conference will have revealed how profound is the contribution of science to that task ; and how grave is the responsibility of statecraft to see that the fruits of planning by men of science are not misused, and to secure the free enjoyment by all of the greater health and leisure which science has made possible.

What is equally significant is that this partnership of science and statesmanship in the building of a new world order is only possible in the nations that still remain free. Without full freedom science cannot long persist, for the fountain heads of new knowledge and creative thought dry up and the quest for truth degenerates into the practice of a technique or cult. This we have already seen happening in Germany, though as many countries know to their cost, science is not yet dead in that country. None the less, the persistent interference with freedom of scientific investigation, of the expression of scientific thought, and with the international interchange of thought had already some time before the War led to a marked deterioration in the quality of scientific work in Germany, especially in fields of new and fundamental research. The British Association Conference in itself is a welcome reminder of the immense and incalculable assets, which are ours in the struggle against Nazism, through the international exchange of scientific thought still possible among the free peoples and the exiled men of science in their midst.

These are truisms obvious to any scientific worker, but it is well that they should be so clearly stated for a wider public, as has been done in the Declaration of Scientific Principles adopted at the final session of the Conference (see p. 393). The

Declaration indeed contains nothing new. It is an educational instrument of the first order, and if it is studied aright by scientific workers and by statesmen and administrators, there should be an end to the charge that in Great Britain, ministers of State or the Civil Servants under them are insufficiently equipped in scientific knowledge or grasp of scientific method and technique.

This Declaration of Scientific Principles is no mere statement of the conditions upon which such co-operation is possible. It demonstrates first and foremost the extent to which the future of science is bound up with that of democracy and the overthrow of Nazism. This struggle is part of the age-long struggle of scientific workers to preserve freedom of thought, of investigation and of expression in the face of unreasoning prejudice, stagnation and repression. The Declaration is an open renunciation of neutrality and an acceptance of special responsibility in the struggle against a tyranny which threatens to overwhelm intellectual liberty everywhere.

The acceptance of such responsibilities is not, however, prompted by the mere instinct of self-preservation, the conviction that to-day complete freedom of thought and interchange of knowledge and opinion are supreme necessities. It is equally prompted by a consciousness of the harmony of interests and aspirations between science and democracy itself. As the Declaration insists, full freedom of expression is of the essence of both science and democracy : where thought is enslaved both wither and decay.

More than this, since the direction of and resources available for scientific work are determined by the social and economic conditions in which the scientific worker finds himself, science is equally concerned with the economic freedom, the third freedom enunciated by President Roosevelt, and all that is implied in the adjustments of social and economic life, required for its realization. This is not merely a matter of the application of scientific knowledge or the mobilization of scientific resources for the acquisition of fresh knowledge in fields insufficiently explored. It is a question of outlook, of the adjustment of ways of living to facilitate the full and free adaptation of ideas to new conditions.

If, therefore, the Declaration of Scientific Principles is an affirmation of those principles upon which it has long been recognized that the fellowship of science is based, and of opposition to any policy of power which deprives men or nations of their free practice, it is equally a challenge to intense mental effort and clear vision. The vision of the possibilities inherent in the contribution of science to the solution of post-war problems and to the building of a nobler world order which the deliberations of the Conference have given, needs to be supplemented by exactly such a statement of principles and challenge to thought and endeavour.

It is well, therefore, that all should understand the basic implication that science must be the partner, not the handmaid, of the statesman or administrator. The State must impose no limits on liberty to learn, opportunity to teach or power to understand if society is to reap the full advantages of scientific thought and knowledge. Science can co-operate while retaining its independence. To sacrifice its independence may destroy co-operation by destroying science.

That truth can scarcely be emphasized too strongly to-day, and there was no more hopeful sign at the Conference than its ready acceptance by Government spokesmen as by the spokesmen of science. Equally vital is the stress laid in the sixth and seventh points of the Declaration on the world fellowship of science. Science truly has the world for its province, and the discovery of truth as its highest aim. The pursuit of scientific inquiry demands unrestricted international exchange of knowledge as well as complete intellectual freedom, and can only flourish through the unfettered development of civilized life. The Conference itself bears witness to the extent to which such international fellowship is still possible in Great Britain and to the hope which may justly be entertained of re-establishing it in Europe when the Nazi power has been destroyed. It may well be hoped, however, that the Conference with this pointed Declaration will stir us to use far more effectively than hitherto the immense moral and intellectual resources in international co-operation which we possess, not alone through our allies but also through the presence of *émigré* men of science from Germany and the occupied countries of Europe.

Any partnership must be based on mutual understanding and respect. No scientific worker, therefore, can fail to mark and honour the pledge given in the fifth point of the Declaration. Men of science are among the trustees of each generation's inheritance of natural knowledge. It is, as they attest, their determination to foster and increase that heritage by the fidelity of their guardianship and service to high ideals, shown to-day in their devotion in the defence of that heritage in the present struggle, no less than in the planning and thought which must go to safeguarding it in a new order yet to be. To scientific workers no less than to the administrator or statesman, the Declaration is a summons to thought and action. To both it may well bring the reflection : *noblesse oblige.*

SKILLED MEN IN THE STATE SERVICES

ONE of the most striking features which has emerged from the recent debates in the House of Commons on war production and on the coal industry, when attention was focused on serious deficiencies in the Government's man-power policy, is the extent to which such deficiencies are due to neglect to use scientific methods or knowledge. Shortcomings in policy are, in part at least, due to the absence of the knowledge essential for a right decision. Failures to use man-power or woman-power to the fullest advantage are equally due to the neglect to use scientific knowledge and method in the selection of personnel, whether in industry or in the armed forces. Absenteeism and other causes of lost time or defective output are due as much to neglect by management of experience acquired as long as twenty-five years ago as of the methods of management and administration which in recent years have rapidly acquired sound claims to be considered a science as well as an art as to failings of the workers themselves.

The importance of the contribution of science in this field has been well illustrated in a further broadsheet on man- and woman-power issued by Political and Economic Planning (P E P), in recent reports from the Select Committee on National Expenditure, and in interim reports of the Kennet Committee on the Calling Up of Civil Servants and of the Beveridge Committee on Skilled Men in the Services, which have appeared almost simultaneously. All alike point to certain matters in which the national effort falls short of the maximum through neglect in the past of scientific method or knowledge. Not all these defects can be remedied immediately. The Select Committee indeed suggests that the system of selection by testing could only be giving the fullest value to the Forces at the present time if it had been in use already for ten or twenty years.

The handicap which has been placed on our war effort by such neglect in the past is particularly well illustrated in this twenty-second report of the Select Committee and in the Beveridge and Kennet Committees' reports, all the more emphatically from the restraint which characterizes their recommendations and their warning against expecting to achieve rapid results by a sudden reversal of policy. The Select Committee points out that two types of test are at present necessary in the Forces: a simple intelligence test to ascertain if a man or woman is suitable for further training as a specialist, and a special aptitude test to determine what his or her particular work should be.

The latter tests must be designed by persons in the closest touch with those who have wide experience of the type of work to be carried out, and it is advisable to proceed gradually with their application. The Committee thinks that they should probably not be used at present outside such technical corps as the Anti-Aircraft and the Royal Armoured Corps. By the wider use, however, of the former simple testing of intelligence and by also ascertaining the capabilities of recruits by tests applied by the Ministry of Labour and National Service before they are posted to a corps, it should, in the Committee's view, be possible to remove many of the present anomalies. Other recommendations include a test of mental capacity level of those called to attend a medical board after registration and the rapid discharge of unsuitable personnel, as well as the grading of new intakes into classes for training in accordance with their intelligence levels.

The Committee, in addition, recommends that better use should be made of the capabilities of younger men, and while it recognizes that the qualities essential to an officer cannot be ascertained solely by testing, and recommends that the system of reports by commanding officers as to the suitability of men to be entered as cadets should be continued, these should be reinforced by a system of tests many of which have yet to be devised. The principle that officers should as a rule be selected from those whose intelligence, as measured by tests, reaches a certain level is, however, far-reaching, and its adoption may well make an important contribution to the discovery and selection of leaders in the armed forces and in civil life. There is no more vital problem for democracy to-day than that of throwing up its potential leaders in all ranks of society and training them for the duties and responsibilities they must carry whether at the highest or at intermediate levels.

The Beveridge Committee's interim report on skilled men in the Services indeed shows that the responsibility of making the fullest use of skill and knowledge is fully appreciated. Both in the Army and in the Air Force the necessary work of modification, repair, maintenance and servicing of machines and instruments of war, in the Committee's view, is now being performed with a notable economy of skilled men, secured by a high degree of dilution and extensive and well-designed arrangements for training. In many such matters of organization the armed Forces have long been far ahead of industrial or civilian establishments generally. Moreover, vigorous efforts are being made by the Army and Air Force to discover men now in the Forces not already engaged on such

work whose qualifications make it likely that they could undertake it with success or could be trained to do so.

In spite of this, in view of the military programmes, a large increase of men engaged on such work is inevitable, exceeding the numbers who can be obtained within the Services by training or transfer, and although the information before the Committee in respect of the Navy was less, with the development of the war at sea the time has probably come when substantial addition to the recruiting of skilled men for the Navy has also become inevitable. Moreover, the report comments on the vital importance of guarding against the danger that the machines on which the lives of fighting men and the safety of the country depend may have to be entrusted to hands insufficiently skilled under inadequate supervision.

No scientific worker can fail to appreciate that this is a much more serious risk than the use by the Services of an excessive proportion of skilled men in relation to unskilled men on repair and maintenance. That such a choice may require to be made emphasizes the importance of eliminating another type of waste, not so much of scarce specialized skill in engineering and allied trades, as of physical strength or of education, experience and ability, to which the report also directs attention. Many men of military age are doing clerical, storekeeping and other light work in the Services which could be done by women or by older men. Until, however, the extensive plans already prepared in the Service Departments for substitution of women for men in all suitable kinds of work are realized, and so long as men of military age are used on work within the capacity of others, whether with or against the will of the Service Department, the Government will not escape criticism for waste of man-power.

On this question of remedying defects in the development or execution of policy the Kennet Report on the Calling Up of Civil Servants throws a significant sidelight. After the War of 1914–18 the Civil Service did not revert to normal recruitment on any substantial scale for nearly ten years. Meanwhile, recruitment was almost wholly from ex-Service men. In the clerical, executive and analogous fields there is an abnormally large proportion of persons between the early forties and the late fifties and a low proportion between thirty and forty. On the other hand, the thirty to forty group, or for the higher personnel, the twenty-five to forty group, is understood to contain many of the best of these with experience.

Such facts have to be taken into account in considering withdrawals from the younger group, while they indicate the basic reasons for some of the criticism that has of late been levelled against the Civil Service. Civil servants cannot be blamed for the consequences when the advice that they have given has been ignored by their Ministers or by the Cabinet, but the Civil Service as a body must bear a fair share of the responsibility if the techniques for obtaining information and for shaping and presenting policy lead to an excessive proportion of decisions proving to be ill-advised. The age-structure described by the Kennet Committee is what might be expected if the Civil Service as a whole tended to be using obsolete or inadequate technique and was not quite abreast of technical, scientific or social developments.

It follows from this that if the Kennet Committee is right in its opinion that the process of substituting women and older men for men of military age which is still in progress in the Civil Service can now be extended and accelerated, it is of the utmost importance to see that the loss of efficiency involved does not outweigh the advantage to combatant strength. The Committee recommends that this should be done by raising the age of reservation for Civil Servants in specified grades to much the same degree as it is being raised for reserved occupations in general, and that this should be accompanied by the cancellation of all deferments. Allowance must, of course, be made for exceptions, but the test must be whether deferment is necessary to provide for the efficient discharge of work essential under war conditions. Where the work is necessary and substitution wholly impracticable, deferment might be granted for an indefinite period. Similarly, efficiency demands a reasonable time to provide and train the substitutes, particularly in the higher grades, while the contemplated extension and acceleration of calling-up underlies the Committee's observation on the striking examples of waste which have already occurred through delay in rectifying the return to the Civil Service of men who were invaluable in their former office and where removal has been the cause of inefficiency and loss of man-power.

If the new drive to secure the full use of our man- and woman-power is to have its proper effect this test of efficiency must be kept in mind at every stage. It is from this point of view that the recommendations of the successive reports of the Select Committee on National Expenditure are of surpassing importance. There is no room for departmental failures in supervision, such as that of repair work in shipbuilding or reconditioning, or of individual eccentricities such as those of the trade union delegate upon which the Committee comments trenchantly in twentieth report. Such treacherous activities must be swiftly and ruthlessly suppressed.

The whole of the twenty-first report of the Select Committee is concerned with this question

of eliminating waste of man-power, from the point of view of seeing that available labour is used as effectively as possible. It is of the utmost importance that, with our limited man- and woman-power, the output of every worker should be increased to the maximum. For this purpose it is necessary not merely that the individual worker should work his hardest, but also that the work should be organized as carefully as possible. It is this latter aspect that has received inadequate attention from the Departments concerned, and many of the problems it involves cannot be solved without scientific study.

Once again the Select Committee finds it necessary to direct attention to the neglect by managements or departments of the experience gained in the War of 1914–18, and particularly to utilize the services of the Industrial Health Research Board in inquiries into such problems as the number of working hours per week which gives the best output in any particular kind of industry. Neglect of this kind is far more damaging than absenteeism to the national effort, and the Committee points out that while a high rate of absenteeism is not always associated with bad management, good management certainly reduces it.

The Committee recommends that the Industrial Health Research Board's rightful status as the proper body for research into industrial health should be recognized. The Board should work in the closest co-operation with the Production Departments and have every opportunity to carry out investigations on a scale wide enough to cover the main problems of industrial health and efficiency in war. For this purpose its staff should be strengthened, and one of the first objects of inquiry should be the best length of working week for a wide range of different kinds of work, particularly the working week giving the best continuous output over a long period.

More important than the question of Sunday labour is that of securing that on the other six days of the week factories and plants are employed for as much of the twenty-four hours as possible. Only a minority of factories are working twenty-four hours a day, because a sufficient labour force has not yet been recruited and trained. Consideration should also be given to wages, for in so far as high wages are the result of bad rate-fixing they operate to cause loss of output.

Management, however, remains one of the most important factors affecting output, and the evidence shows that idling is frequently due to bad management or want of supervision. The pace and general spirit of a factory come from the top, and the importance of setting a good example in energy, punctuality and enthusiasm need not be stressed. Moreover, lack of work and enforced idleness, whether due to mismanagement inside the factory, insufficient stocks to tide firms over temporary breakdowns of supply, or to irregular allocation of contracts by Production Departments, cause loss of output by inducing a sense of frustration in workpeople which ultimately lowers their morale.

Many of the observations in the report are the everyday practice of modern management, and it is a sad reflection on the general standard in war-time that the Committee should find it necessary to allude to such commonplaces as the value of taking workers into the confidence of the management in overcoming difficulties, the importance of handling a recruit correctly at the outset of his career, the need for appointing men to positions of authority for their personal qualities of leadership, tact and organizing ability as well as for their technical skill, or to recommend that the Factories (Canteens) Order 1940 should be amended so as to require factories engaged mainly in work on behalf of the Crown, with a sufficient number of workers to make the arrangements feasible and necessary, either to provide their own canteens or to make suitable alternative provision. Similarly, although considerable scientific work has been carried out on the effects of conditions of lighting and ventilation upon output, and desirable standards of heat, light and ventilation are known with some precision for broad categories of work, these standards have frequently not been applied. It might well be argued further that the question of incentives to output, also stressed in the report, is largely a management matter, particularly in demonstrating to workpeople the real need for ever-greater output, which in war-time should be the ultimate stimulus.

If this admirable report appears to stress chiefly the responsibility of management, particularly in raising the quantity and quality of managerial ability and in increased collaboration with the workpeople, it equally indicates the contribution to be made by the other two partners in the industrial team. Departments must accept a greater responsibility for the working conditions which affect the output of industry and for removing the external obstacles to output such as inadequate housing, transport and feeding arrangements. Workpeople must recognize that the conditions of industry during the War cannot in the nature of things be ideal, that special efforts are needed to overcome difficulties, that improvements, however energetically pursued, take time to achieve, and they must also realize the importance of the contribution of the individual to the total output.

When all this has been recognized the influence of the central administration remains a vital factor. There lies the main responsibility for keeping constantly under review the disciplinary provisions of the Essential Work Orders or for the executive action

involved, removing from reservation a persistent offender who refuses to obey a direction under the Essential Work Orders. Moreover, the bringing to maximum efficiency of all members of the labour force is only one of the three stages of man-power policy which must be co-ordinated and developed by the Government itself. Unless this stage finds its place side by side with the systematic withdrawal of man years for the armed Forces and the civil defence services and with the determination of the civilian man-power necessary to maintain the output of goods and services for the armed Forces, for essential civil needs and for export, maldistribution of the existing labour force will persist and our war effort fall short of its maximum.

The P E P broadsheet gives an admirable analysis of the principles and problems involved in each of these three stages. The Schedule of Reserved Occupations is the sheet anchor of man-power policy, and it is clear from the Beveridge report that it is improbable that there are too many skilled men in the Forces relative to the number employed in industry. The criticism that in the distribution of man-power the armed Forces are favoured at the expense of production is less easy to answer and is likely to be further provoked by the present situation in the U.S.S.R. and the revision of the Schedule. The P E P broadsheet points out that the criticism might well be met so far as the Army is concerned by making its members both soldiers and workers. The Home Guard indeed represents one such solution, the use of specialized units such as Pioneers and Royal Engineers for the clearing of debris or maintenance of communications after an air raid another, while the use of soldiers in harvesting or their release for industrial employment is a further method, the possibilities of which should be fully explored during the winter months, particularly in view of the success of the system in Germany during the past winter.

It is upon the transfer of man- and woman-power to essential work that attention is chiefly focused at the present time. It would appear from the reports already cited that the Government is still without much of the essential information upon which to base a sound decision as to the civilian man-power necessary for war production and essential civil needs and exports. This alone would account for the hesitancy of the Minister of Labour and National Service and for his reluctance to use his wide powers of compulsion. None the less, as the broadsheet points out, it is very clear that the Schedule requires drastic revision, especially in the removal of reservation from many mobile girls who could be replaced by older women.

Here, as elsewhere, the evidence does not warrant the belief that our objective will be reached by persuasion alone. In the concentration of industry very few satisfactory arrangements have been made, while concentration has not yet been enforced upon the vast retail trades. There are far too many shops, even food shops, particularly butchers', and a reduction in these numbers will have to be considered, just as a reduction in women personnel is being done.

Again, the broadsheet points out that in the concentration of industry, efficiency indicates the importance of keeping management intact if possible, and turning efficient management over to the running, for example, of a factory dispersed on strategic grounds. Training again still receives inadequate attention, as well as the necessity of altering production methods not only to economize on skilled labour but also to simplify training. The economy of man-power in essential industry demands careful study if the periodical bottle-necks due to the shortage of workers with a particular kind of skill or experience are to be minimized, the transfer of workers from one type of work to another not impeded by difficulties in regard to wages or other conditions and the utmost advantage taken of youth and mobility among women.

The reports to which we have directed attention, and the P E P broadsheet do not afford ground for either pessimism or optimism. They point indeed to definite shortcomings and indicate ways in which those shortcomings and mistakes may be and are being rectified. The dominant impression they leave is, however, the immense importance of the scientific contribution in thought, in technique and in material. No adequate man- and woman-power policy can be evolved without the fullest possible use of scientific methods of inquiry and of scientific analysis of definitely ascertained facts. The execution of such a policy will equally fail of its objectives unless from top to bottom there is the fullest use made of scientific and technical knowledge already available, the persistent application of scientific methods to all appropriate problems and unfailing readiness to utilize the help which scientific workers or scientific organizations can give in all matters affecting production, output or welfare. Impatient as scientific workers may sometimes be that more use is not made of their individual services, whether through the failure of the Central Register to function properly or through other causes, this is a far graver concern of them all—the responsibility of seeing that no opportunity is missed of bringing home to the nation, from the Government downwards, of the immense and vital contribution which science can make in our war effort. In that task they will rarely find such abundant ammunition as lies to their hand in the pages of the P E P broadsheet and these reports.

SCIENCE IN PROGRESS

Science in Progress

By L. J. Stadler, F. W. Went, J. F. Fulton, Douglas Johnson, Alfred C. Lane, H. P. Robertson, Carl D. Anderson, Duncan A. MacInnes, J. W. Beams, J. C. Hunsaker. Edited by George A. Baitsell. Second Series. (The Society of the Sigma Xi devoted to the Promotion of Research in Science: National Lectureships, 1939 and 1940). Pp. xii+317. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1940.) 24s. net.

THE tremendous advances which have been made during the past century all along the scientific front are not, it must be admitted, entirely without their counter-vailing disadvantages. Even if we reject the suggestion put forward by Rabindranath Tagore that science is the modern Mephistopheles to which mankind has sold its soul in return for material benefits destined in the end to bring about its destruction—a thesis which at the present time seems painfully plausible—and admit that the passion for scientific discovery which characterizes our age is one which must and should be satisfied, the extent and variety of the knowledge gained raise intellectual and philosophical problems of a formidable kind. A century ago a not unduly gifted individual might, if he cared to take the trouble (and many did) have a reasonably comprehensive view of what was afoot in all branches of what could then truly be called natural philosophy. To-day there is no natural philosophy; only an ever-increasing number of sciences, each with its specialists directing a closer and closer scrutiny on an ever-narrowing field of vision.

This is a pity; and not merely from a philosophical point of view. Fresh advances and new techniques developed in one science frequently open the way to big discoveries in apparently unrelated fields of action. Moreover, it is more than possible that the biggest advances of all are to be achieved in that no-man's-land which lies between the biological and physical sciences, and will be won by a combined attack from both sides. It is obvious that one of the most urgent needs of to-day is for better liaison work between the sciences. Possibly some enlightened university may be persuaded to re-establish the professorship of Things in General once held by the late Herr Teufelsdröckh at the University of Weissnichtwo. In the meantime, and as a sort of substitute, the Society of Sigma Xi has established in the United States a series of national lectureships to serve something of the same purpose. Reports of ten of these lectures, given in 1939 and 1940, make up the contents of this volume of "Science in Progress".

It is a very attractive and impartial cross-section of the sciences which is offered to the reader in this very attractive and handsomely produced volume. The subjects covered include the experimental alteration of heredity, the regulation of plant growth, experimental studies of the functions of the frontal lobes in monkeys, chimpanzees and man, how the earth shows its age, recent advances in aeronautics, and, of course, the expanding universe and cosmic rays. In addition there are articles of rather more specialized interest on the ultracentrifuge, on the motions of ions and proteins in electric fields, and on mysterious craters of the Carolina coast. Merely to read these subject headings is something of a tonic; it helps to restore one's faith that, however incompetent man may still be in the political sphere, he has some claim to his self-bestowed title of *Homo sapiens*. To appraise each separate article in the volume is beyond the scope of this review, and any selection would, probably, only reflect the personal tastes of the reviewer. I can only place on record that one reader, at any rate, found every article—each of which has been written by a research worker of international reputation in his subject—of interest, and that the collection as a whole was an intellectual stimulus.

The lectures, one gathers from internal evidence, were designed primarily for men of science, though no doubt intelligent non-scientific specialists were welcomed. Such an audience is one to put even the most distinguished lecturer on his mettle; for in spite of the division of interest, on which stress has already been laid, the unity of the scientific spirit remains unimpaired. Most of us know that our colleagues in other sciences are capable of most pertinent and valuable criticism of our theories when once we have succeeded in making clear to them what these theories are. The principal barrier between the sciences is not so much a difference in interest as a difference in vocabularies. Science suffers, along with the rest of mankind, from the curse of Babel! More than one of the authors of "Science in Progress" allude to this difficulty. Prof. Fulton, for example, writes "The title of this chapter should really have been 'Encephalization and functional localization in the primal frontal lobes.' However, I feared that this might frighten the physical scientists, for, although they invent words far more terrifying, they always seem a little intimidated by the simple words we devise in the biological sciences!" It cannot truthfully be said that all the distinguished authors who have contributed to the present volume have been equally successful

in overcoming the language difficulty. Some have taken great pains to do so; others seem scarcely aware that the problem exists. One does, occasionally, become aware of the substance behind the common complaint made by the layman that men of science "write an unintelligible jargon." What, for example, can a reader whose knowledge of chemistry is, perhaps, forty years out of date gather from such a statement as "Proteins can be broken down into various amino acids in addition to prosthetic groups?" And yet, as the author might justly retort, how can the matter be put more clearly? Probably science, like poetry, to which it has many affinities, is actually untranslatable.

No series of disconnected lectures, however distinguished, can produce the reintegration of science, so much to be desired. Yet the present volume stimulates the hope that such a reintegration is possible. Through all the diversity of topics one becomes aware of a unity of purpose, a unity of method, and a unity of thought much closer than one had imagined. Biology and physics do not seem so remote in outlook as one had sometimes thought. It is to be hoped that world conditions will not interrupt the activities of the Sigma Xi, and that the third series of "Science in Progress," promised for the autumn of 1942, will duly make its appearance.

J. A. CROWTHER.

METHOD IN TEACHING CHEMISTRY

Numerical and Constitutional Exercises in Organic Chemistry

By Dr. J. L. B. Smith and Prof. M. Rindl. Pp. ix+214. (London: Methuen and Co., Ltd., 1941.) 7*s*. 6*d*.

Calculations of Qualitative Analysis

By Prof. Louis J. Curtman and Sylvan M. Edmonds. Pp. vii+156. (New York: The Macmillan Company, 1940.) 8*s*. 6*d*. net.

THESE books originate, one from South Africa, the other from the United States, both countries of wide open spaces in which the larger proportion of the inhabitants live by doing practical things. Such environment might be expected to have an influence on the teaching in the universities at least of chemistry, which is essentially a practical subject, and it comes as a surprise to find students expected to give much time to mathematical exercises. Would-be chemists should certainly be taught mathematics up to the limit of the time available in their course, but this should be real mathematics. As Eric Gill has written in his autobiography, we are educated by the doing and not by the learning: this is the whole secret of education whether in schools or in workshops or in life. The actual business of learning—the acquiring of the use of tools without using them—is the very smallest part of a proper system of education. Some would say it is impossible, and it is largely for this reason that some of the hard-headed men in Lancashire and Yorkshire are sceptical of the value of a university education for their sons.

We do not go to school to learn football or cricket but to play them: there are not a few who hold that games are the backbone of our public school system, as is evidenced by the fact that those who are proficient in them are sought after for the better positions in life.

Organic chemistry in particular must be taught at the bench. The great school of von Baeyer at Munich was essentially a practical one, so was that of Emil Fischer in Berlin. Most of the chemists of repute, German or foreign, went to one or other of them; they toiled all day long and often far into the night in the laboratory, seldom went to a lecture but read avidly and omnivorously the original literature; hence they had the widest knowledge of chemistry as a whole. W. H. Perkin brought the bench tradition to England, and there are few among our leaders of yesterday and to-day who escaped his influence.

All the achievements have been at the bench. It is unfair to the student, to my mind, to keep him in the classroom when he should be at the bench. The original sin must, of course, be laid at the door of the examination, which means that the student is taught to satisfy the examiners and not the subject by which he hopes to earn his livelihood. There is much talk of peace aims: surely the greatest would be to abolish the present system of examinations which has put a dead hand on learning in schools and colleges, and to induct the student into a "brave new world" though of a more moral kind than Huxley's. There would then be fewer disappointments when an honours degree man finds himself a failure in practice in the late twenties.

Teaching as exemplified by these books is essentially on the wrong road: we must see that it is marked "no entry, unexploded bomb", in the most unmistakable way.

While we have criticized the system it would be unfair to be unkind to the books themselves. It is

scarcely possible to deal with them in detail, they represent a careful attempt to treat the subject-matter according to the views of the authors.

To us sugar can never be $C_{12} H_{22} O_{11}$; we think of its crystals, its properties, its stereochemical formulæ; of the uncertainties which surround this; of those who have wrought at the solution of the problem; of how it is made by the plant in Nature; of the sheer marvel of its molecular architecture and the changes produced by shifting a hydroxyl group here and there; of the ways in which we can perhaps effect its synthesis.

Such an insight into a single substance is pure poetry: it has a spiritual implication beside, forced on us by the sheer orderliness of things. The student could be taught all this in a few lessons and become a seeker after knowledge with poetic fervour, which he could never achieve from a course of numerical and constitutional exercises.

E. F. ARMSTRONG.

SIGNIFICANCE OF THE HYPOTHALAMUS

The Hypothalamus and Central Levels of Autonomic Function

Proceedings of the Association for Research in Nervous and Mental Disease, December 20 and 21, 1939, New York. (Research Publications, Vol. 20.) Pp. xxx+980. (Baltimore, Md.: The Williams and Wilkins Co., 1940.) 10 dollars.

THIS volume contains thirty-four separate papers on different structural, functional and clinical problems related to that part of the brain which is known as the hypothalamus. A brief historical résumé of the literature and a reprint of Fröhlich's memorable contribution on a case of dystrophia adiposa genitalis form a fitting introduction to the papers which follow. Written by authors who have done outstanding work on the problems discussed by them, the various papers provide not only a review of previous work but also much unpublished new data.

On the structure of the hypothalamus there has been an attempt to codify the nomenclature of the cell masses and fibre tracts in the region, which will be of the utmost value to future workers. The unravelling of the connexions of the nerve cells and the fibre tracts which pass through this part of the brain has not yet been completed, but notable advances have been made. The very incompleteness of our knowledge of its structure makes the story of the functional significance of the region all the more fascinating. Knotted together in this relatively small part of the brain are the most diverse functions—cardiovascular control, water, carbohydrate and fat metabolism, control of body temperature, some aspects of sexual behaviour, gastro-intestinal regulation, an influence on pituitary activity, some measure of sleep control, and an effect on the somatic muscular responses. Contributions on each of these functions are to be found in the section on the physiology of the hypothalamus. The relation of the hypothalamus to the endocrine glands and especially to the pituitary body is discussed in many of the papers. Although the exact anatomical connexions between the pituitary gland and the central nervous system are by no means clear, abundant experimental and clinical evidence is disclosed to show that the nervous control of pituitary functions is of great importance.

Studies of diseases and new growths involving the hypothalamus are included in the third section of the book. Such studies are invaluable as they provide a means of checking in man the value of stimulation and extirpation experiments on animals. Actual stimulation of the region has been carried out in conscious human patients with results identical with those found in experimental animals. Changes in personality and emotional disturbances have been correlated with certain lesions which seem to release the hypothalamus from an inhibiting cortical control. The clinical and experimental evidence for such a control over hypothalamic activity seems now to be well founded. From the evidence now available, it seems probable that the hypothalamus can be regarded as the 'motor cortex' of the vegetative nervous system, receiving stimuli from, and acting under, the dual control of the thalamus and cerebral cortex. More explicitly, the hypothalamus is that part of the brain which maintains by means of the vegetative nervous system and certain endocrine glands the constancy of the *milieu intérieur*, or the internal environment of the organism.

The 'evenness' of the papers and the lack of serious overlapping are worthy of comment. There is every sign of careful editing in the production of the volume. While the papers are the products of those working in North America, there is ample reference to the activities of those in other countries, and especially to those pioneers who opened up, more than eleven years ago, in the proceedings of the Association for Research in Nervous and Mental Disease, the field which has been so abundantly fruitful. An extensive bibliography completes an outstanding volume which will be for many years an invaluable book of reference.

CONFERENCE ON SCIENCE AND WORLD ORDER

WHILE the older sections of the British Association from A to M have been obliged to suspend their activities because of the exigencies of the War, the Division for the Social and International Relations of Science—the youngest and, one might say, the adopted child of that elderly yet virile organization—organized a Conference on Science and World Order at the Royal Institution, London, during September 26–28. On the day preceding its public sessions, at a luncheon arranged by the British Council and attended by many members of the Government and Diplomatic Corps, Mr. Anthony Eden, the Secretary for Foreign Affairs, expressed the growing appreciation by our higher statesmen of the value of scientific training, scientific research and the applications of science in the conduct of public affairs (see p. 403).

The six sessions of the Conference were well attended by a varied and representative gathering. At the opening session on Friday, September 26, a message of commendation was received from the Prime Minister (see p. 403); and a letter outlining the basis of the Conference was sent to H.M. the King, from whom a message was received later (p. 403). Sir Richard Gregory, president of the British Association, and chairman of the Division for the Social and International Relations of Science, then gave the inaugural address. He announced that sub-committees to deal with the main topics raised at the Conference would be appointed by the British Association.

The deliberations during the sessions covered the relations of science to government, human needs, world planning, technological advance, post-war relief and the world mind, respectively. The many valuable papers presented will be more amply noticed in a series of articles in forthcoming issues of NATURE. A perspective of the proceedings alone will be attempted here.

The discussion on "Science and Government", under the chairmanship of Sir Richard Gregory, was opened by Viscount Samuel, distinguished in the fields of both statesmanship and philosophy. He paid tribute to the scientific spirit, outlined the present organization of Government research departments (see Lord Hankey's speech in the House of Lords, NATURE, April 12, p. 432), and advocated the establishment of science attachés to the principal embassies. Prof. A. V. Hill, M.P., Foulerton research professor of the Royal Society, followed with a warning to scientific men to be continually aware of the dangers arising from interest, prejudice and emotion, dangers which are certain to creep in when one attempts to deal with government and politics. He stressed the need to remove barriers between "government science" and "independent science" by the creation of more scientific advisory bodies attached to departments of State and the Cabinet.

Prof. L. Gulick, of the U.S. National Resources Planning Board, followed with a description of the New Deal's successful Tennessee Valley Authority and its achievements. Six main river dams have been completed and three more are under way on the Tennessee River itself, and several more on its tributaries for the multiple purpose of improved navigation, electrical power development and flood control. The present installed generating capacity now exceeds one million kilowatts, and by 1944 this will have been doubled. The revenue derived from the sale of electricity covers the operating expenses of all the Tennessee Valley Authority programme, which includes social work tending to improve housing, education, health and the standard of living generally.

Dr. P. W. Kuo, vice-minister of finance and former president of the South Eastern University of China, outlined the many ways in which a scientific approach to industrial problems has enabled China to strengthen its resistance to aggression, and how a reform of the currency system has contributed to China's ability to utilize to the utmost its resources. Prof. J. D. Bernal sketched five stages in the application of scientific method based on information, research, development, execution and control. Prof. J. B. S. Haldane gave a spirited address comparing the Academy of Sciences of the U.S.S.R. with the Bank of England in their relation to their respective Governments. Dr. A. Labarthe, editor of *France Libre*, formerly lecturer in technology and thermodynamics at the Sorbonne, speaking in French, pleaded for the establishment of a ministry of scientific research which would erect trial industrial plants for the investigation of new processes. Dr. J. Negrin, formerly professor of general physiology in the University of Madrid and lately head of the Spanish Republican Government, supplied the reflections of a professional man of science forced to take a leading part in the management of State affairs.

The second session of the Conference, which dealt with "Science and Human Needs", was under the chairmanship of H.E. the American Ambassador, Mr. J. G. Winant. He said in a speech which

directed attention to the need for eliminating both the threat of force and of poverty: "We must abolish both hunger and the sword as a means of forcing labour."

Prof. E. Abel, formerly of the University of Vienna, expressed the gratitude of his many Austrian colleagues who are working in Great Britain.

Sir John Orr, director of the Rowett Research Institute, Aberdeen, implemented the chairman's appeal with fact and figures. He spoke with his usual vigour and clarity in favour of a food policy that would raise the health and intellectual standard of the masses, and advocated the appointment of an international convention to prepare the plans for a post-war food policy.

Sir Harold Hartley, chairman of the Fuel Research Board, gave a well-documented address on the world's heat and power requirements.

The Right Hon. Herbert Morrison, Home Secretary and Minister of Home Security, without committing the Government, agreed that a maximum and not minimum standard of living should be aimed at, and said that a scientifically defined welfare standard creates a principle for international collaboration. He ended upon a challenging note: "Shall man's mind become the master of material needs or shall it be tossed hither and thither by surging and misdirected economic forces?"

Dr. Wilder Penfield, president of the Royal College of Physicians and Surgeons of Canada, mentioned the action of official methods and stressed the necessity of making full use of suggestions given by men of science outside the official machine. He made a strong appeal for an air-borne ambulance service, in which a beginning might well be made in the Near and Middle East, and he read a manifesto from McGill University asking that research workers should reconsider their work in relation to the urgent requirements of war.

Prof. W. G. Holford, professor of civic design in the University of Liverpool, discussed in a paper the correct use of land in the country and the opportunities and limitations of planning. Mrs. Mary Agnes Hamilton, of the London County Council, spoke as a representative of consumers, and made an appeal to men of science to help the poorer housewife do away with the drudgery associated with house-work.

The last speaker of the Friday session, Prof. A. C. G. Egerton, professor of chemical technology in the Imperial College of Science and Technology, pointed out the problems of food and power, both of which are derived from the sun's radiation, and pictured diagrammatically a scheme of human activities illustrating the interconnexions.

Saturday morning's session on "Science and World Planning" was under the chairmanship of H.E. the Soviet Ambassador, M. Maisky. He pointed out that in the U.S.S.R., a country with unified and strong administration, which has accepted the principles of planning, twenty years has been necessary to reach the present state of planning. One must not expect that the necessary requisites of world planning can be crowded into a day or two. M. Maisky said that Soviet men of science were unable to attend the Conference owing to difficulties of communication, and their speeches that were to have been relayed by radio had been jammed by German interference. He read a message from the U.S.S.R. Academy of Sciences in which Soviet men of science expressed their solidarity with their colleagues in allied countries in their combined effort to achieve final victory over barbarity and tyranny.

A message from General Smuts sent by radio and reproduced by gramophone was also heard by the Conference. "Science", said the voice from the other hemisphere, "is the greatest torch which the spirit of man has kindled in the modern world, and nothing—not even in the dark hour of our civilization—should be allowed to interrupt its kindly light. With our victory, science will not merely be reinstated to her honoured status, but a new era will open for her. Our aim is not only more knowledge and ever-new discovery of truth, but also the promotion of social welfare and the building of a great society of free people."

The session began with a paper by Lord Hailey discussing the colonial problems of the British Empire. He showed how the changed conception of the function of the State, namely, its intention to deal with the welfare of the individual, is bound to have a beneficial repercussion upon colonial policy. From his wide experience in Africa he illustrated the type of problems which have to be solved. A collaborator of Lord Hailey, Prof. G. Findlay Shirras, professor of economics in University College, Exeter, directed attention to some of the problems confronting India, with its large and ever-increasing population.

Prof. Alvin Hansen (political economist, Harvard University, and special economic adviser, Federal Research Board) outlined the current programme of research in the United States relating to post-war reconstruction, such as soil conservation, agriculture, nutrition, urban development and international relations. "It is my conviction", he said, "that internal prosperity in my country could be very much promoted by continued economic collaboration between Great Britain and the United States of America—collaboration to pursue parallel and co-ordinated policies of internal expansion."

Prof. P. Sargant Florence, professor of commerce in the University of Birmingham, analysed the problems of distribution of industry and advocated greater dispersion of "foot-loose" industries to ensure the blending of town and country amenities and outlook.

Prof. J. Métadier brought greetings from the Free French Forces and submitted a fairly detailed plan for the creation of an international society for promoting scientific research.

Mr. D. P. Riley, of the University of Oxford, who is known for his work on X-ray crystallography, spoke as one of the younger generation of British scientific workers. He pleaded for a greater share for the younger men of science in the councils of scientific planning, in the laboratory and in the factory. He advocated setting up sub-committees of the British Association to investigate further the problems raised at the Conference; also the formation of an international committee, including workers of all grades and, if possible, the setting up of a club in London which would serve as a meeting-place for scientific men of all nationalities. The president, Sir Richard Gregory, intervened at this point and expressed his sympathy with the younger scientific investigators. He pointed out that so far as the Division for the Social and International Relations of Science of the British Association is concerned, they have taken an important part in its development. As he had mentioned earlier, in his presidential address, the Council of the Association will be asked to set up special sub-committees to consider the problems brought to the notice of the Conference.

Mr. Hugh P. Vowles, in a forceful address on "Giant Power and World Planning", compared the Soviet electrification programme with that in other countries, and concluded that only under a non-profit system is it possible to develop the power resources in a co-ordinated scientific manner.

Captain H. Barnard, of the Free French Forces, brought greetings from General de Gaulle and was warmly received by the Conference. He discussed the steps necessary to render it impossible for Germany to wage another war, and stressed the point that men of science have means of helping to prevent economic crises, which are the major source of widespread unemployment leading to such movements as Nazism.

A communication from the Right Hon. Lord Onslow dealt with the conservation of wild life and advocated the establishment of national parks. Mr. O. N. Arup discussed the elimination of waste by planning and standardization. Dr. Othmar Ziegler outlined what a rationally extended international system could do to ease social tension.

Mr. Maurice Dobb, lecturer in economics in the University of Cambridge, pointed out that the postulates of early economists no longer hold good owing to monopolist competition, and advocated socialist planning. "Unless there is a boldly conceived action by the State on an extensive scale," he declared, "we may face a post-war slump that will put 1920 and 1929 in the shade."

The fourth session of the Conference covered the field of technological advance and was reminiscent of the usual British Association gatherings. The President of Czechoslovakia, Dr. Beneš, took the chair. He recalled that the first president of his country, the late Prof. Masaryk, had been a distinguished man of science, and declared that science and technology have played a decisive part in the progress and prosperity of his country. After analysing the growth of technology and its danger when used as an instrument for nationalist and expansionist aims, he concluded: "This conference of scientists is the manifestation of the urgent and categorical needs of the free world to liberate subjugated science, to use science and technology in the post-war world for the work of real, social reconstruction. But it is also a manifestation of our definite and firm will not to permit in the future the misuse of great inventions and all kinds of technological progress for criminal and destructive purposes."

The first paper was by Prof. C. H. Desch, scientific adviser to the Iron and Steel Research Council. It covered the field of conservation of natural resources, showing that while agricultural products may be periodically renewed under rational cultivation, mineral ore deposits are not inexhaustible. Indeed, copper, tin, gold and phosphate deposits, at the present rate of production, are believed to have a life of less than a century. Commercial exploitation tends to "skim the cream", and the proposed international authority which will control the fair distribution of mineral resources will likewise have to deal with the question of conservation.

Dr. L. E. Howlett gave an account of the progress made by Canada's optical industry, greatly helped by Research Enterprises Ltd., a Government-owned company working in close co-operation with the National Research Council. Dr. G. Coumoulos (Greece) stated that Greek industry and technology have tended to be much influenced by outside considerations instead of developing organically from the needs of the country.

Mr. A. J. Couzens presented a paper, prepared by himself and Mr. M. Yarsley, upon the uses and advantages of plastics. He stated that the War has given a powerful impetus to the plastics industry and that plastic material can be developed to meet specific needs.

A French man of science—who desired to remain

anonymous—attempted a mathematical analysis of technological progress. The development of aviation and other technical developments may be represented by an exponential law; that is, such factors as the amount of goods and passengers carried, if plotted with their logarithm against time, give a straight line (law of organic growth). The same speaker suggested that there should be organized a special team of research workers whose duty would be to foresee the problems likely to arise from new technological development, or from present trends solve them before they become acute. For example, the problem of new sources of energy must be solved before the reserves of fuel are exhausted.

Dr. C. H. Waddington, of the Strangeways Laboratory, Cambridge, predicted, among the likely technical advances in biology, more extended technique of vernalization, utilization of hybrid vigour, and the production of entirely novel crop plants by means of such drugs as colchicine. Animal productivity will be increased by artificial insemination, and the hormonal control of sex development may well play a part in the poultry and perhaps the dairy industries.

The next paper to be presented was by a group of three Czechoslovak investigators, Drs. G. Lewi, R. Eisler and J. Cisar, and dealt with the technology of insufficiently utilized raw materials or waste products. This was followed by an outline of the technical advance in the building industry by Mr. R. Fitzmaurice, principal scientific officer to the Building Research Station, and by a communication from Dr. J. H. de Boer on the need for closer collaboration between universities and industrial research laboratories.

A rather different note was struck by Dr. J. E. D. Swann of the Association of Scientific Workers in a paper on the "Organization of Science for War Production". In an incisive manner the speaker criticized the inefficient utilization of scientific workers in the war effort and the insufficient exchange of information between different manufacturing concerns.

Prof. Enrico Volterra returned to the purely technological aspect with a paper on some recent applications of the theory of elastic dislocations in civil engineering, and finally Mr. Ritchie Calder wound up the afternoon's proceedings by pointing out that a definite picture of a "second industrial revolution" resulted from the many papers presented to the Conference.

"Science and Post-War Relief" was the theme of the fifth session, under the chairmanship of H.E. the Chinese Ambassador, Dr. Wellington Koo. "The trying experience of relief workers at the end of the last world conflagration", Dr. Koo said, "shows clearly that rationalization and co-ordination through the use of scientific methods are necessary to the accomplishment of efficient results free from delay and waste." Like the chairmen of previous sessions, Dr. Koo emphasized that only a successful issue to the present struggle will enable scientific people to build according to their plans a new edifice of world order.

Mr. Philip Noel Baker, M.P., formerly professor of international affairs in the University of London, suggested that Governments should agree to strive towards an international food standard on the lines set out by Sir John Orr, and outlined the relief work done after the War of 1914–18 by the Nansen organizations and other bodies connected with the League of Nations.

Mr. R. Allen, of the American Red Cross, gave some of his recent experiences of relief work in Unoccupied France, and stated that a reservoir of medical supplies is being accumulated at Geneva and elsewhere to be used in case of epidemics. Prof. J. Löwy, of the University of Prague, mentioned the curative resources of Europe—sea and mountain air, climatic factors and medicinal springs—which should be made more generally available, and suggested that a special body should investigate this subject. Dr. Kuo Zing-Yang expressed the desire of Chinese men of science to collaborate in solving post-war problems, and pleaded that China should be granted full partnership and not be treated from the point of view of diplomatic expediency.

Mr. W. L. Kelly, of the International Institute of Wool, speaking as an Australian farmer, asked that measures should be taken now towards the storage of foods in such countries as Australia. Mme. Priestman-Breal, of the Friends Relief Mission, gave an excellent address on the psychological approach of relief work, based upon her experience in Poland after the War of 1914–18.

Sir John Russell, director of the Rothamsted Experimental Station, whose original theme was to have been the "Impact of Science on Agriculture", substituted instead a talk on "Restoring the Scorched Earth". He appealed to the competent authorities in the United States and Canada to ensure that the numerous varieties of crops specially suited to their different regions, which have been produced by Russian plant breeders, should be given a temporary home under suitable conditions.

Dr. Anni Noll, of the Pioneer Health Centre, Peckham, London, gave some of the findings from that unique experiment in the promotion of healthy surroundings for the family as a unit. Dr. E. Kodicek, lecturer in psychology in the University of Prague, advocated an efficient organization of scientific experts and politicians. Dr.

Eugen Wallach, formerly manager of the Hirsch-Kupfer Gesellschaft, discussed the post-war control of metal resources and the human aspects of industrial reconstruction. Mr. H. G. Norman, chairman of the British Federation of Social Workers, stated that in the new post-war world, human emotional needs must have a place, and trained social observers, experienced in the art of human understanding and social healing, will be needed. The session ended with an address by Mr. Hugh H. Smith, of the Rockefeller Health Foundation, on the role of epidemiology in the post-war world.

The last session of the Conference was devoted to "Science and the World Mind". The chairman, Mr. H. G. Wells, confronted with a much too limited time to do justice to the subject, arranged for his address to be duplicated and distributed; he requested the speakers to comment on several definite points, a federal world language, the problem of spelling and phonetics, the meaning of words and the storage and distribution of ideas. Unfortunately, Mr. Wells's suggestions did not reach the various contributors in time, and while some made a commendable attempt to rewrite their papers or adapt them to the chairman's suggestions, the majority spoke on their prepared subjects.

Prof. L. Hogben, professor of zoology in the University of Birmingham, had originally prepared a paper on education for government. In a brilliant improvisation he sketched the history of the idea of auxiliary international language, towards which some four hundred attempts have been made from the seventeenth century onwards.

Mr. J. G. Crowther, of the British Council, dealt with education of the public, and Prof. Max Born, professor of natural philosophy in the University of Edinburgh, with the teaching of science. "The human race", Prof. Born said, "is slowly awakening from a dream mind into a state of clearer consciousness." Dr. J. Needham, reader in biochemistry in the University of Cambridge, developed the theme that a principle of increasing organization is discernible in living beings and culminating in social organization counter to the principle of degradation of energy to a dead level.

Mr. J. A. Lauwerys, of the University of London Institute of Education, under the title the "Scientific Content of General Education", presented the views of a group the members of which are concerned with the training of science teachers "Mere giving more time to science is not enough," he said; "the scientific method and the scientific attitude must be fostered and the material must be chosen from a wider field and treated in a modern manner."

Mrs. S. Neville-Rolfe, of the British Social Hygiene Council, in a well-delivered address, advocated an institute of social biology and stressed the need for a wider understanding of the emotional nature and the requirements of man. The causes of war, she stated, lie in the lack of ability, character and emotional development of man himself. A true democracy can only be created by the emotional and intellectual development inspired with a positive purpose in life. Youth can appreciate the opportunity and accept the responsibility of mustering the forces of evolution and directing them to the development of man.

Prof. Skalinska, of the University of Cracow, spoke on behalf of the Polish men of science, men and women who had to find refuge in other lands, and Count Zamoyski assured the Conference that no man-made creeds will in future obstruct the relations between Poland and the U.S.S.R.

Prof. Julian Huxley, like some of those who had preceded him, did not speak on his prepared subject, "The Scientific View of Education as a Social Function", but undertook the difficult task of summarizing the main points that had emerged during the proceedings of the Conference.

The meeting was then taken over by the president, Sir Richard Gregory, who repeated the promise that committees would be appointed by the Council of the British Association to prepare considered reports upon several main points that had been raised. He then presented the Charter of Scientific Fellowship (see p. 393), a concrete proof of the new spirit which the Division for the Social and International Relations of Science has been formed to foster.

Thus ended a memorable Conference, leaving a mixed impression of light and shade, of brilliant flashes of intellect and dark patches of unco-ordinated effort. Unfortunately, in practically every session the time allowed to the speakers became progressively shorter towards the end of the meeting, irrespective of the nature and the importance of the subject-matter. There was much lack of unity and proper relationship in the too numerous papers, insufficient drive towards results to be achieved, and lack of clear vision of the potentialities of the situation. Some would claim that the Conference was nothing but a sterile hybrid between the free-platform attitude of previous British Association meetings on one hand, and the purposeful drive which inspires many younger scientific workers on the other. Others hold that in spite of all imperfections, one can discern in these deliberations the amœbic beginning of a world mind, as yet halting and incoherent, but full of promise for the future.

THE COMMONWEALTH OF SCIENCE*

INTELLECTUAL freedom is an essential condition of progressive human development. Throughout the ages, individual scientific workers have been forced to fight and to suffer in order that life and intellect may be preserved from the effects of unreasoning prejudice, stagnation and repression. To-day they feel compelled to proclaim their special responsibility in the struggle against any subjection which would lead to the betrayal of intellectual liberty.

The war now devastating our world involves an age-old conflict of ideas. Liberal minds of the last generation were convinced that the battle for independence of thought and free expression of opinion was finally won; yet once again this conviction is being violently assailed. The fight to maintain it must perforce be resumed, for the danger of losing the heritage of freedom seems graver than ever before.

During the past third of a century, changes in the conditions of life have come about, more profound than any in human history. Distance has been virtually abolished; cognizance of events has become simultaneous throughout the world; all men have become neighbours. Fresh discoveries open up undreamed-of potentialities for good or for evil, but their proper use demands correspondingly high ethical standards.

While only a century ago the village was an almost self-sufficing unit, to-day the world is our unit. To such a disturbing change of outlook and obligations, we are not yet attuned, and we must readjust our way of living, for only by the fullest and freest adaptation of ideas to new conditions can this readjustment be achieved. Intense mental effort and clear vision are now needed.

In the past, freedom for the written and spoken word was desirable; to-day, complete freedom of thought and interchange of knowledge and opinion are supreme necessities. Full freedom of expression is the very essence of science as well as democracy: where thought is enslaved science, like democracy, withers and decays. Men of science must, therefore, declare clearly and emphatically the principles which underlie their beliefs and guide their conduct.

Accordingly, the principles of the fellowship of science are here affirmed; and it is maintained that any policy or power which deprives men or nations of their free practice convicts its agents of an iniquity against the human race.

Declaration of Scientific Principles

1. Liberty to learn, opportunity to teach and power to understand are necessary for the extension of knowledge, and we, as men of science, maintain that they cannot be sacrificed without degradation to human life.

2. Communities depend for their existence, their survival and advancement, on knowledge of themselves and of the properties of things in the world around them.

3. All nations and all classes of society have contributed to the knowledge and utilization of natural resources, and to the understanding of the influence they exercise on human development.

4. The basic principles of science rely on independence combined with co-operation, and are influenced by the progressive needs of humanity.

5. Men of science are among the trustees of each generation's inheritance of natural knowledge. They are bound, therefore, to foster and increase that heritage by faithful guardianship and service to high ideals.

6. All groups of scientific workers are united in the fellowship of the Commonwealth of Science, which has the world for its province and the discovery of truth as its highest aim.

7. The pursuit of scientific inquiry demands complete intellectual freedom and unrestricted international exchange of knowledge; and it can only flourish through the unfettered development of civilized life.

* The New Charter of Scientific Fellowship presented by Sir Richard Gregory, Bart, F.R.S., president of the British Association, at the end of the Conference of Science and World Order.

G. B. CAVE, CHARTERHOUSE ON MENDIP

By F. J. GODDARD AND R. A. J. PEARCE
UNIVERSITY OF BRISTOL SPELÆOLOGICAL SOCIETY

IN these modern times the opportunities for making new geographical discoveries have become very scarce, and for this reason the opening up of a large new cave system, such as G.B. cave, within twelve miles of Bristol, should be of considerable interest to the scientific world.

The range of Mendip Hills in Somersetshire extends from the upper valleys of the Frome and Brue in the east some 23 miles down to the Bristol Channel. It is generally about 6 miles in width, and its south-western face descends to low moors drained by the Axe, and other streams, to Cheddar and Wells. It is with this area that the Spelæological Society of the University of Bristol is concerned.

The Mendips consist principally of carboniferous limestone, but at its highest point, Blackdown, which rises to a height of more than 1,000 ft., the limestone and the limestone shales have been eroded, leaving a cap of Old Red Sandstone. The numerous caves to be found in this district are formed by the action of surface water penetrating the strata at the juncture of the Old Red Sandstone and the limestone.

To the south of Blackdown, the strata dip in the direction of the famous Cheddar Gorge, and on this face there lies a pitted and mine-scarred patch of ground aptly named Gruffy Field. Close by runs the Roman road which once carried Mendip lead to the coast of the Bristol Channel. A small stream runs into this field and disappears at the base of a cliff at the end of a small gorge which it has carved for itself in bygone ages. This stream and neighbouring swallow holes, or swallets, have been investigated by the Society for the past twenty years; most notable of these excavations was that by E. K. Tratman, now professor of dental surgery at King Edward VII College of Medicine, Singapore, who always believed that a large cave system lay beneath the surface at this point.

GENERAL VIEW OF THE MAIN CHAMBER OF G.B. CAVE. THE ROOF OF THIS CAVERN IS 120 FT. ABOVE THE FLOOR-LEVEL AND THE TOTAL LENGTH OF THE GORGE, OF WHICH IT IS THE LARGEST PART, IS 786 FT.

About 100 yards west of the point where the stream now penetrates the rock, there is a dry swallet where it formerly disappeared. At the instigation of F. J. Goddard, who was secretary of the Society at the time, and the co-discoverer of the cave, Dr. C. C. Barker, work was begun in this choked streamway early in 1939. Owing to the small size of the rock fissure, progress in the actual stream bed was found to be very difficult, and another shaft was sunk a few yards away, to a final depth of twenty feet. At the bottom of this hole was revealed a small crack from which

Erratic stalactites on roof of 1st grotto, G.B. cave

there issued a draught strong enough to extinguish the flame of a candle held in it; this gave us an indication that a cave system lay within reach below. However, it was found impossible to enlarge the crack in the solid rock by normal means, and we resorted to the use of a charge of explosive. This proved most effective, and after the debris had been cleared, it was found just possible to force an entry through it into a small passage.

This soon opened up into a gallery leading into a grotto of extraordinary beauty. In this grotto the calcareous formations take on an amazing variety of shapes. Both stalactites and stalagmites branch and twist into fantastic shapes for the formation of which there has as yet been advanced no satisfactory explanation. These erratics have been termed 'helictites', and there are very few caves known where they exist in such profusion as they do in all parts of G.B. Cave. It is interesting to observe that they have not been found elsewhere on Mendip, except for a few examples in a new chamber of East Twin Swallet, in Burrington Coombe, recently opened up by the Society.

The way on from this chamber is up a 10-ft. climb into another grotto rivalling the first in its fairy-like beauty. From this there leads a series of climbs and crawls 300 ft. in length which try the fortitude and tax the agility of even the most hardened caver. They end in an unpleasant water-crawl about 2 ft. high and 18 inches wide, which we have named the Devil's Elbow; emerging from the end of this, one looks down into a large boulder chamber from a height of about 15 ft. The amount of icy water rushing along this passage and over the drop prevented further exploration for some months, but in March 1940 four members were able to fix a rope over the lip and descend into the chamber.

We were delighted to find that a large rift led steeply out of this chamber down over a series of potholes to a narrow slit in the rock. Squeezing through this one by one, we found ourselves in an enormous chamber, so high that the light from our acetylene headlamps would not illuminate the roof. We followed the stream along its floor, over a mass of shattered boulders until we were halted by a drop. The chamber, or, as we have christened it, the 'Gorge', widens out at this point into a cavern about 100 ft. in width and 120 ft. high, and its roof is hung with magnificent formations, which can best be viewed from a gallery which runs high up along one wall. Lining one side of the chamber are hanging tapestries of white stalactite fully 60 ft. high, while large stalagmite bosses, many feet across, are set in the walls; in fact, it is only by using lengths of magnesium ribbon as illumination that the true magnificence of this cave can be appreciated, so huge are its dimensions.

After negotiating the drop, we found that the Gorge gradually narrowed down to end in a small sump chamber, where the stream disappeared underneath the rock in a syphon, or sump. At this point one is 480 ft. below the surface, and the total length of the Gorge is 786 ft., so that as a single continuous chamber it must be one of the largest in Great Britain.

Subsequent exploration revealed a new series of chambers and passages leading from the roof of the main chamber, some of which ascend to within 100 ft. of the surface. These chambers contain

Erratic stalactite or helictite, from 1st grotto, G.B. cave

some of the most beautiful formations of all, including some fine erratics four or five feet long, and some curious, slender, apparently windswept stalagmites.

A number of true cave pearls have also been found here, together with a large amount of so-called coral formation, making the cave unrivalled in Mendip both from the point of view of size and beauty.

Owing to its size, and the narrowness and intricacy of its upper passages, the survey and photography of the cave have not been easy. Our work has, in addition, been held up by the salvaging excavation undertaken by members of the Society on the site of our museum, the valuable contents of which were destroyed by fire during an enemy air raid on Bristol.

However, the survey has been completed, and we are now concentrating upon obtaining a comprehensive photographic record of the cave, which offers unlimited possibilities in this direction, and upon an attempt to follow the stream still farther into the heart of Mendip past where we now lose it.

ASPECTS OF MATHEMATICAL LOGIC

By Dr. Harold Jeffreys, F.R.S.

It is recorded that when a pupil asked Confucius what he would do first if he had absolute power, the Master replied "I should reform language". (The development of the theme in the text of the "Analecta" is scarcely worthy of it, but incorporations are suspected.) The history of mathematical logic since "Principia Mathematica" affords an admirable illustration. Even before that great work, the need for unambiguous definitions and for the explicit statement of even the most harmless hypotheses was a main source of inspiration; but later investigators have found that ambiguities remained. In particular, there was a confusion between a symbol and the thing designated by it, and a propositional function was sometimes a property and sometimes what Prof. Willard Van Orman Quine in his recent book, "Mathematical Logic"*, calls a "statement matrix", that is, an expression that would become a statement if it contained names in place of variables. It was hoped also, especially in Russell's popular works, that the actual existence of numbers could be demonstrated in terms of the theory of classes.

It seems to me that such an approach was bound to be unsatisfactory if the scientific use of mathematics was to be justified. For equality of number between classes has to be defined in terms of an empirical method of comparison, and an empirical hypothesis is used in the statement that two classes defined in terms of some property, found similar in one test, will be found similar in another. This hypothesis is so elementary that it has usually passed unnoticed, but if mathematics is justified only for classes satisfying certain axioms, it follows (1) that we cannot significantly speak of the number of individuals with a certain property if the number is liable to change, (2) if there are in the world no classes at all that satisfy the axioms, the whole system breaks down. The fundamental objection to this approach, from the point of view of an empirical scientist, is that we must be able to query and test any empirical statement whatever, and this cannot be done if some such statements are selected and made part of the method of analysis itself.

Later writers have mostly abandoned Russell's attempt; the best known is probably Carnap. Axioms are now regarded as abstract statements, and a clear distinction is drawn between a thing and its name. Logic reduces to stating the rules of a language and investigating what kind of statements can be made in the language. Actual demonstration of the existence of structures formally similar to those laid down in the abstract rules is left to the empirical sciences. Even where the rules are not satisfied they can still serve as a useful standard of comparison. The chief aim now is to show that the rules themselves do not lead to contradiction; ordinary language, if not supplemented by rules that have been discovered by persons still living, does lead to contradictions—some are sufficiently elementary to be given in "The Week-End Book".

It is easy to show that if two contradictory propositions are demonstrable (in the ordinary sense) in a language, then every proposition in the language is demonstrable. If we have p and $\sim p$, and we consider any other proposition q, then p entails (p or q); but $\sim p$ and (p or q) together entail q; hence p and $\sim p$ entail q. Similarly, of course, they entail $\sim q$. This result in one form or another occurs in all the modern languages of mathematical logic. Now if every proposition capable of being stated in a language could be proved both true and false, the language would be of little scientific use; and this argument shows that a useful language must contain no contra-

* Mathematical Logic. By Prof. Willard Van Orman Quine. Pp. xiii+348. (New York: W. W. Norton and Co. Inc.; London: George Allen and Unwin, Ltd., 1940.) 21s. net.

dictions at all. But it also follows that if we can find a proposition in the language that cannot be proved in the language, then the language is consistent. It is not easy to find such propositions; to prove that a proposition cannot be proved is a very different matter from merely failing to prove it. Carnap, however, produces one. But it might happen that every proposition could be proved true or false in the language without any being provable to be both. It has been proved, however, by Gödel that any consistent language that includes arithmetic contains a statement that can be neither proved nor disproved. In his present book, Quine gives a proof that such a statement exists in his system even before arithmetic has been constructed. This is towards the end of the book, and the argument is difficult. But as a result of this type of work we have now much stronger reason than we had for asserting the consistency of logic and mathematics, and we also know that they can never be complete: we can never lay down formal rules that will enable us to decide whether any statement expressible in the language is true. Twenty years ago we might have had doubts about consistency but thought that somehow every proposition could be either proved or disproved, possibly both.

Quine has introduced a novel feature in the treatment of the theory of types, which is much simpler than in Russell and Whitehead's analysis. In the latter the famous contradiction about whether the class of all classes that are not members of themselves is a member of itself or not is resolved by including in the logic of classes a rule that the statement that a class is a member of itself is neither true nor false, but simply meaningless. This led to much complication, because, for example, a real number was defined as a class of rational numbers, and therefore no rational number could be a real number; the real numbers that we ordinarily regard as rational fractions belong to a different type. Quine finds that he can manage with a less drastic criterion. He still finds that certain classes need special treatment, but that he can give a formal rule for recognizing them by inspection of their definitions, and that it is not necessary to deny the meaning of such a class; but it cannot be a member of another class. He is thus able to introduce a universal class V consisting of all things that can be members. This would be impossible in the "Principia" analysis, since no class could include members belonging to different types. We can apparently say now, if we want to, that $0{\cdot}5000\ldots$ is the same thing as $\frac{1}{2}$ and not something different in kind.

Quine's criterion for the recognition of anomalous classes might be compared with the epistemological considerations given in a recent paper by Bridgman. I think that closer inspection would show that the process of constructing them could never be carried out because no consistent order could be given for carrying out the steps. Carnap and Quine both exclude epistemological considerations from their analysis, but I think that without them they lose a valuable source of suggestions, and one that the empirical sciences cannot possibly dispense with.

I would have liked to see some reference to the difficulty in formal expression of logic propounded by Lewis Carroll in "What the Tortoise said to Achilles". The point is that if we know p and (p implies q) we can infer q and proceed to assert q by itself; this is an essential principle of inference. But if we try to state it symbolically and use it, we simply build up longer and longer expressions and never reach a stage where we actually say 'q'. We can *see* what the rule means and act on it, but we cannot state it formally. This is recognized in "Principia". But some of the modern systems try to avoid the notion of meaning altogether and to speak only of symbols as actual specimens of printers' ink, giving rules for substitution of one type of expression for another. We can see what this means, and carry out the various cancellings permitted by the rules. But it seems to me that if the notion of meaning is eliminated, Lewis Carroll's difficulty is reinstated, and the process will only build up longer expressions and never enable a theorem to be asserted by itself. I think that Quine's system retains enough of the notion of meaning to permit an answer to it, but it should be made explicit.

I have been particularly interested in these recent developments because I have been trying to do for induction what Carnap and Quine seem to have done (in different ways) for deduction: to construct a self-consistent formal theory that will enable statements of certain types to be expressed, but such that the theory by itself says nothing about the truth or probability respectively of any empirical proposition. "Principia" assumed some empirical laws, and so, I think, do the 'printers' ink' theories. But for Carnap and Quine logic and mathematics are languages and their study is the analysis of those languages. This is analogous to the only satisfactory interpretation that I can find of the use of numbers to express probabilities; that it is the choice of a language to give more compact and less ambiguous expression than ordinary language can. If this is true in probability theory, it must be true of pure mathematics, which deals with the extreme cases of probability. There are advantages as well as disadvantages when workers follow totally different routes, and nevertheless arrive so near the same destination.

THE INTERNATIONAL EDUCATION BOARD

By R. WEATHERALL,
ETON COLLEGE

THE International Education Board was set up in 1923. The idea behind it was to help to make good some of the ravages of the War of 1914–18. The money, which amounted in all to nearly twenty-eight million dollars, was provided by John D. Rockefeller, jun., who with characteristic modesty imposed no conditions on the manner in which it should be spent, except that it should be used for "the promotion and advancement of education throughout the world.*" The inspiration with regard to the policy which should be followed came almost entirely from the late Dr. Wickliffe Rose, under whose guidance the Board has achieved something which for its breadth and diversity must be unique in the technical progress of the world.

What is education ? In Rose's mind it became for the most part, not the dissemination of certain accepted ideas and cultural patterns, for that he felt might well be left to the various national Governments, but the desire to forward the understanding of the natural world by the best possible means. The claims of educational training, particularly training for agriculture, were not overlooked, but they played a subsidiary part in the comprehensive scheme which he put forward for the support of the best research institutions and the most promising scientific workers, whose work was being held up for lack of funds. His primary object was to add to the total stock of human knowledge, and his scheme he looked upon as "tactics in the campaign against human ignorance." No considerations of national prestige were allowed to stand in the way, and except for agriculture, no attempt was made to strike a balance between the competing claims of the different branches of science, for in Rose's view, "all knowledge is inter-related, and if we help in any one field we help in all the others." So it came about that the greatest scene of the Board's activities lay in Europe, including the British Isles ; but a small number of individual projects in the United States received some of the largest grants, while smaller ones found their way to such places as South Africa, China, the Philippines and New Zealand.

In all, "fifty-seven universities, research centres, and other institutions were provided with new buildings, equipment, endowment and other material aids ; and 603 individuals, chosen for their promise of future usefulness, were assisted in their higher education, given opportunity to study under world authorities in their chosen fields, introduced to new pastures of research under conditions which at the time seemed favourable to their development. Through grants for these various purposes, thirty-nine countries, representing Europe, Africa, Asia, Australasia, and the Americas, were aided."

A visit of Dr. Rose to Europe in 1923 initiated a scheme under which the whole world, but particularly war-worn Europe, was scoured for young scientific workers showing exceptional promise, whose studies were held up through lack of means. After careful scrutiny these were granted travelling fellowships for a year, which enabled them to profit by the best scientific experience available in the world in their own particular line. Within the five years, 1923–28, an exchange of workers and of scientific ideas took place on an unprecedented scale.

But this scheme of fellowships in science would have been held up by the cramped facilities existing in many of the leading research institutions. Realizing this, the International Education Board made available large sums to be spent upon buildings, equipment and endowment. One of the first institutions to benefit in this way was the Institute of Theoretical Physics at Copenhagen, under Niels Bohr. There facilities for research and for teaching were greatly augmented. Grants from the Board also made it possible to provide new accommodation for the Institute of Physical Chemistry at Copenhagen, where J. N. Brönsted had won international fame, and had attracted many students from foreign lands.

The University of Göttingen received very material help. Its pre-eminence lay in the spheres of physics, mathematics and mathematical physics. In 1926 assistance from the Board led to the enlargement of the Physical Institute, and enabled a large number of visiting students to work under the distinguished leadership of James Franck, Max Born, and Robert Pohl. The same year also saw a considerable sum going to build and equip a new Mathematical Institute, which provided far better facilities for the work and teaching of such distinguished mathematicians as Hilbert, Hermann Weyl, Richard Courant, Landau, Herglotz, Felix Bernstein, Paul Bernays, Otto Neugebaur, and

* Education on an International Scale : a History of the International Education Board, 1923–1938. By George W. Gray. Pp. xiii+114. (New York: Harcourt, Brace and Co., Inc., 1941.) 2 dollars.

Emmy Noether. Thanks to the International Education Board, Göttingen became truly pre-eminent in its own particular field.

Proceeding along the same lines the Board came to the aid of the laboratory for low-temperature research under Kamerlingh Onnes, at Leyden, and supplied much-needed equipment with which The Svedberg of the University of Uppsala might pursue his investigations into protein structure. In Paris the Board founded and endowed a professorship in mathematical physics, and allotted further sums for the erection and upkeep of the Institut Henri Poincaré. One small donation, with pleasant associations, amounting to five hundred dollars a year, for a short period provided Einstein with the services of an assistant in making a fresh approach to the mathematics of the quantum theory.

In Stockholm grants from the Board completed the sums necessary for the erection of a Biological Institute. These grants were forthcoming chiefly because of the distinguished contributions which von Euler had made to the chemistry of fermentation. The Board also made itself mainly responsible for the finance of the new Institute of Cosmical Physics at Tromsö, for the Institute of Physics and Chemistry at Madrid, and for the new research outpost of the Jungfrau High Altitude Institute on the Sphinx, the rocky spur adjoining the Jungfraujoch in Switzerland. Much attracted by the zeal and energy of Prof. José Castillejo, Dr. Rose placed great hopes on the new Institute in Madrid. Smaller subventions went to the Universities of Utrecht, Vienna and Warsaw.

In the field of astronomy a comparatively small sum financed the preparation of a bibliography of books, papers and other publications in all languages referring to the minor planets. A considerably larger grant was made to Harvard University to be spent in moving the southern astronomical station from Peru to Mazelspoort, near Bloemfontein in South Africa, and for improving its equipment. There the 60-inch Rockefeller reflector was erected, and as a consequence, the surveying of the southern stellar hemisphere, and in particular of the outer galactic systems, has been considerably extended, to the tune of about five thousand photographic plates each year now pouring into Harvard from South Africa.

But perhaps the one project which will endure as the most symbolical monument to the policy and achievements of the International Education Board is the 200-inch telescope on Mount Palomar. This project required boldness in its conception, it needed very careful preliminary survey work, it depended upon the solution of many intricate problems in applied physics, and it could be carried through only with the expectation that large sums would be forthcoming to bring it to completion. Six hundred thousand dollars, for example, were spent on experiments with fused quartz for the mirror before the decision was reached to use a special form of Pyrex glass. As a result of careful estimates the International Education Board decided in 1928 to set aside six million dollars for the whole project, including the necessary housing and site, as well as the astrophysical laboratory and shops at Pasadena. Of this sum a balance of four hundred thousand dollars remained unspent at the beginning of 1941 to meet the final expenses of construction and installation: fine testimony to those who drew up the original plans.

The biological sciences were not neglected. At the same meeting at which it was decided to finance the 200-inch telescope, a large-scale building programme was agreed upon to bring all the scattered and greatly overcrowded faculties in botany, zoology and general physiology at Harvard University into one single Department of Biology. Not only were material facilities greatly increased and given new dignity, but the co-ordination of these allied branches of biological science promises to have far-reaching results. Mainly at August Krogh's instigation, something similar had been achieved some years earlier at Copenhagen, where grants from the Board assisted in the foundation of an Institute of Physiology to serve for the study of physiology, biochemistry, and biophysics. Thus Copenhagen received assistance from the Board for three separate institutes, each world famous.

Edinburgh was the recipient of generous donations from the Board for its Department of Research in Animal Breeding under F. A. E. Crew; and for housing and equipping the Zoological Laboratories on a new site. The Jardin des Plantes in Paris was given a grant for the rehousing of its priceless herbarium. Assistance was given to the Marine Biological Station at Naples to get it going again after the disturbances of the War of 1914–18, and smaller donations went to the Marine Biological Station at Plymouth, the Botanical Conservatory of Geneva, the French Society of Biology at Paris, the University of Utrecht and the University of Cracow.

Even the claims of scientific publications were not overlooked. A grant was made to the University Foundation in Belgium to help in making good the losses in books and periodicals suffered in the War of 1914–18. Funds were also made available to nurse a number of technical journals in Italy through the critical post-war years. A grant to the International Bureau of Weights and Measures provided an important new measuring instrument, a set of reference books, and a much-

needed addition to its overcrowded building. Similar grants assisted in the publication of two volumes of the Annual Tables for the International Committee of Annual Tables of Constants and Numerical Data in Paris, and for a set of International Critical Tables for the National Research Council in the United States.

In agriculture alone was any attempt made to finance broad experiments in education. Based upon what had already been achieved in the United States, the first of these projects to be set going was a scheme of rural clubs in Denmark. This included farm clubs for boys, and similar ones in gardening and domestic economy for girls and women. Within a short time requests were received to establish schemes in Sweden and Finland. Help was also forthcoming for the Village Association in Hungary, and for the Fram-Kursus Institute in Oslo, which provides correspondence courses in forestry and agriculture. But in the sphere of agriculture a far wider range was achieved through the system of travelling professorships and agricultural fellowships. These together covered thirty-nine countries, and five States in the United States, ranging as far away as China and New Zealand. Some of these fellowships were arranged on an exchange basis, with most happy results.

The University of Cambridge received most generous treatment from the Board. Preliminary plans to finance a Department of Entomology were expanded to cover the extension, rebuilding, equipment and support of laboratories for agriculture, and the associated sciences of botany, physiology and zoology, in a co-ordinated scheme. To round off its benefactions to Cambridge, which in all totalled nearly three million dollars, the Board gave a handsome donation to the new University Library.

One promising development was the sponsoring of a co-operative undertaking between Cornell University and the University of Nanking. Cornell agreed to assign each year one of its professors in the Department of Plant-Breeding to spend several months at Nanking, and the International Education Board met all expenses not otherwise provided for. This arrangement came to an end in 1931, by which time trained Chinese workers were available, and the idea of scientific crop improvement had spread to other parts of China.

Other donations for agricultural purposes included sums to enable the International Institute of Agriculture in Rome to carry through the world census of crops and livestock in 1930, and to extend its library facilities. A small donation made it possible for J. O. Veatch to make a detailed demonstration soil survey of a certain part of Scotland. Assistance was also forthcoming for agricultural institutes in Poland, Hungary, and Austria; for the Agricultural College at Hohenheim in Germany; for the Willie Commelin Scholten Laboratory at Baarn, Holland; for the Central Institute of Agricultural Research at Stockholm; for the Institute of Agronomical Research at Paris; and for Rothamsted Experimental Station at Harpenden. A grant to the University of Sofia completed the sums necessary for the erection of a College of Agriculture, which at the beginning of the present War was the "most competent and active outpost of scientific agriculture in the Balkan States."

The humanities were not forgotten, but the policy here was to make large grants to three selected institutions. One of these grants went to the American Academy in Rome, and was used for extensions, for increasing the number of fellowships, and for the permanent endowment of its library. Another made it possible for the American School of Classical Studies in Athens greatly to extend its work, and to excavate the ruins of the ancient Athenian Agora, which has now yielded priceless archæological finds. The largest grant of all rounded off the pioneering work of Dr. J. H. Breasted by providing a truly magnificent building for the Oriental Institute at the University of Chicago: an institute which has become the centre for Oriental studies in the United States, and has set before itself a stupendous programme in archæological investigations.

In the sphere of education as commonly understood generous support from the International Education Board led to the foundation of the International Institute for Foreign Students working at Teachers College, Columbia University. This Institute has been much concerned with the psychology and culture of foreign peoples of non-European civilizations. It has been of great value in developing a new educational outlook in different parts of the world, to which places students have been able to carry back first-hand experience of Western civilization. A timely donation from the Board helped to bring about the re-organization of Negro education at Atlanta University, with better provision for graduate and professional training. Other grants were made to the Phelps Stokes Fund for educational survey work in British West Africa, and to enable African educationists to visit the United States. Support was also given to educational activities in Liberia, including the foundation of the Booker Washington Agricultural and Industrial Institute at Kakata, modelled on the Tuskegee plan of practical education.

Twenty-eight million dollars is a large sum of money. It is small compared with the amounts

available for spending week by week, whether for war or for peace, in the leading countries of the world. The bare summary of what the International Education Board was able to achieve is fine testimony to the vision and understanding of those who were responsible for devising its policy and carrying it out. With them men counted for more than things, but they realized that even preeminent men cannot work without things, of which they deserve the best that are obtainable.

Now, some of the work of the Board is already in ruins. Buildings have been demolished, men of science driven from their homes, prohibited from pursuing their investigations, and some even put to death. In ever-widening circles across the world, all that the International Education Board stood for is in a state of dissolution and suspense, borne down by the forces of nationalism and ignorance which it strove to eliminate. As men of science we may reflect that even that is a natural phenomenon. Reaction and war have come upon us because we have not yet learned to understand and control those mass movements of mankind which are called national policies.

In drawing up his plans Dr. Rose paid next to no attention to the social sciences. That in its way was characteristic of the period and country in which he lived and worked. His feeling was that in these sciences no clear principles are to be found. The principles may still be wanting. Their lack is the measure of how much is waiting to be done ; for it is useless to go on piling up technical information if knowledge of man himself lags so far behind. We may question the economics which rendered so much scientific progress dependent on the fortune of one man, while realizing that without his aid technical science would have made less rapid strides. When the clouds of war lift again, let us hope that still larger endowments will be forthcoming for the progress of knowledge, the fount of all education, and that they will be used to make the threat of war remote, not by force but by international understanding directed to the good of all mankind.

OBITUARIES

Eng.-Captain J. Fraser Shaw

Eng.-Captain J. Fraser Shaw, of the Fuel Research Station, Greenwich, died at his home at Chislehurst on July 23.

As an engineer in the Navy he specialized in the burning of fuel and he took part in the organization of the courses for naval cadets who had to qualify in engineering. Later he was responsible for courses of instruction on oil fuel and turbines. He was present at the Battle of the Falkland Islands and his record throughout the campaign was a brilliant one. He was mentioned in dispatches and after the Battle of the Falklands was promoted immediately to the rank of commander. It may be recorded that he was a magnificent athlete and played for his country at Rugby football, being popularly known as "Rugger Shaw".

The knowledge Shaw had gained upon the use of liquid fuels was recognized towards the end of the War of 1914–18, when he was appointed liaison officer between the Admiralty and the Ministry of Munitions (Mineral Oil Production Department). During this period of his service he obtained a wide knowledge of all processes for the production of oil from indigenous materials, and in view of this special knowledge he was seconded from the Navy to take charge of the Fuel Research Station during its erection. He continued his service until 1922 when he resigned his commission to take up the appointment of chief engineer of the Fuel Research Station and liaison officer with the Admiralty.

As chief engineer of the Fuel Research Station he was responsible for the organization of most of the programmes, and in particular all investigations which were carried out on a large scale. He was interested in the scientific and technical aspects of the carbonization programme, and especially processes for the production of oil by low-temperature carbonization and hydrogenation. In association with Dr. King he read a paper before the Institution of Gas Engineers and received the Gold Medal of the Institution. A year later he described in a Fuel Research Technical Paper the details of the low-temperature carbonization plant which had been designed and erected at the Station and for which he had been largely responsible. His long experience in the burning of oil in the Navy gave him a special interest in methods of heat transfer and in particular the burning of coal in a pulverized form. In order to realize the essence of his work it may be noted that some of the experimental plants at the Fuel Research Station are on such a scale that the results may be applied directly in industry, and it was the object of the organization to translate the observations made in the laboratory into plant which could be operated in industry. He possessed in a remarkable degree a capacity for improvising plants on an intermediate scale by which the inherent features of a process could be investigated in the first place on this scale before proceeding to the erection of a large-scale unit.

Shaw was a most enthusiastic and kindly leader and he brought together the industrial men who had to operate the large-scale units and the directing staff into the harmony which is necessary when laboratory observations have to be translated on to a large scale. His name will not be found on the title-page of many of the publications of the Fuel

Research Organisation because he wished his assistants to receive the maximum credit. It remains, however, to say that every investigator had been helped to the full by his wise and able guidance.

F. S. SINNATT.

Mr. L. A. Boodle

THE death of Mr. Leonard Alfred Boodle, formerly assistant keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew, on August 22, has removed from our midst a very learned botanist and a most conscientious and devoted public servant.

Boodle started his botanical career at the Royal College of Science, and after taking his A.R.C.S. he was for seven years demonstrator at the College under the late Dr. D. H. Scott. Soon after Dr. Scott went to Kew as honorary keeper of the Jodrell Laboratory, Boodle joined him as his private assistant, and it was then that Boodle's valuable work on plant anatomy commenced. Before that he visited South Africa and worked on marine algæ, with the late Mr. George Murray. The genus Boodlea was named after him.

When Dr. Scott resigned his honorary keepership of the Laboratory in 1906, Boodle was put in charge, having been appointed an assistant at Kew in 1904. He was appointed assistant keeper of the Laboratory in 1909 and retired under the age limit in May 1930.

Boodle was blessed with a splendid memory and had a remarkable knowledge of botany and botanical literature; he was a very valuable critic. Diffident of his own powers and most meticulous in all he undertook, he spared no pains in working out fully any problem presented to him, but his published work was not very large and much first-class research work he carried out, unfortunately, was never published. His papers on the vascular structure of the Pteridophyta are a worthy memorial of his careful and exact methods.

Prof. E. J. Salisbury writes: "He was a man of whose profound anatomical knowledge and surefootedness we all had the greatest respect. His extreme modesty and retiring nature led to many not appreciating to the full his great gifts."

ARTHUR W. HILL.

Dr. M. Benjamin

WE have learnt with deep regret of the death in a recent aeroplane accident of Dr. M. Benjamin, while engaged on work for which he was seconded from industry to the Ministry of Supply. He was a physicist of great promise who had begun to make his mark in pure science as well as in applications to industry.

His work in pure physics consists of a number of careful and interesting studies of electron emission from various types of surfaces. The earliest (Benjamin and Rooksby, *Phil. Mag.*, 15, 810; 16, 519; 1933) cleared up in a remarkable way the peculiar features of the emission given by coatings of mixed oxides of strontium and barium. Then followed studies of the migration of barium and thorium ions over various surfaces, the resulting changes in thermionic emission being used to indicate the migration (and evaporation). Quite recently, in collaboration with Jenkins, Benjamin was engaged in the study of electron emission from metal points as a function of direction of emission and surface conditions, studies which are in course of publication by the Royal Society. The observed emission patterns were of great variety and complexity; they promise to provide new and important information for the electron theory of metals, and of the nature and properties of a metal point formed on a single crystal.

There was another side of Benjamin's life and character. He was one of those who took kindly to the practice of maintaining frequent personal contacts with the industry which, in effect, gave men such as him their chance. Although this left only part of his time and energies for his researches, it provided a fund of knowledge on recurrent but unexplained phenomena demanding inquiry. For him, however, the main urge was probably rather in the fact that, in the making of thermionic valves in thousands, the slightest misunderstanding leads to waste and delay; of these he was most impatient, and difficulties increased his activities in factory and laboratory to a fury. Nevertheless, his actual approach was always one of friendly interest, and he was as apt to learn as to teach. This attitude encouraged in all manner of people responsiveness and trust, so that his interventions were not merely accepted but were often claimed with insistence. His most recent work brought out his qualities to the full, with results which will be far-reaching.

That his colleagues in the Laboratory feel his loss to be most grievous goes without saying, but there will be many elsewhere who will miss him and will know the reasons for these feelings.

Prof. C. Bartel

NEWS has reached his friends in Britain that Prof. Casimir Bartel, the distinguished mathematician and former Polish prime minister, was recently executed by the Germans for alleged co-operation with the Russians. His death, at the age of fifty-nine, deprives Poland of a man who would have been most useful to the nation in the future reconstruction after the country's independence is restored.

Born at Lwow, Bartel received a technical education before entering the University of Munich to study mathematics. When he returned to Lwow he taught mathematics (in particular geometry) at the Polytechnic High School, becoming in turn lecturer, assistant professor, full professor, rector and finally principal of this institution of university rank.

In science, Prof. Bartel was the most eminent of contemporary Polish mathematicians. After the War of 1914–18, when Poland regained its liberty, the nation depended upon its men of science and learning to undertake its leadership, and Prof. Bartel was among those who responded to the country's call. In 1919 he accepted the post of minister for railways and communications in Prof. Paderewski's first government, and he was therefore largely

responsible for co-ordinating the three systems previously forming part of the German, Austrian and Russian systems. He resigned in 1922, but four years later became first premier and then deputy prime minister under Marshal Pilsudski. He retired from politics in 1930 and returned to Lwow to resume his scientific and academic interests.

When the Germans occupied Lwow they closed the University and Polytechnic and arrested many eminent men. The fate of Prof. Bartel gives rise to concern for the safety of the other distinguished Polish savants still in Nazi hands. G. D.

We regret to announce the following deaths:

Mr. H. S. Ball, O.B.E., principal of the School of Metalliferous Mining, Cornwall, on September 26, aged fifty-three.

Mr. R. T. Baker, formerly curator of the Technological Museum, Sydney, a well-known authority on Australian eucalypts and pines, on July 14, aged eighty-six.

Mr. D. P. Petrocochino, C.B.E., a well-known benefactor to Greek archæology, one of the founders of the Anglo-Hellenic League, recently in Athens, aged eighty.

Mr. A. H. Smith, C.B., keeper of Greek and Roman antiquities in the British Museum during 1909–25, on September 27, aged eighty.

Prof. Myron Harmon Swenk, chairman of the Department of Entomology in the University of Nebraska, aged fifty-eight.

Prof. Isaac Weinberg, an authority on the Amharic and Abyssinian languages, recently in Warsaw, aged sixty-three.

NEWS AND VIEWS

Conference on Science and World Order

Message from H.M. the King

The following message from H.M. the King was sent to the Conference on Science and World Order, held during September 26–28: "I thank you sincerely for your message on the occasion of the opening of the conference held by the Division of the British Association for Social and International Relations of Science which was so wisely established a few years ago. The social benefits which scientific research, by free practice and under right guidance, can bestow on all mankind grow ever greater. It is right that such benefits should be shared among all peoples alike. I am happy, therefore, to join with you in welcoming the many distinguished scientists from oversea and in thanking them for the free gift of their knowledge. I sincerely hope that this valuable interchange of ideas will further the lofty aims which the British Association has consistently produced since its foundation.—George R.I."

The Prime Minister's Message

The Prime Minister sent the following message to the Conference: "One of our objects in fighting this war is to maintain the right of free discussion and the interchange of ideas. In contrast to the intellectual darkness which is descending on Germany, the freedom that our scientists enjoy is a valuable weapon to us, for superiority in scientific development is a vital factor in the preparation of victory. The presence of representatives of so many different nations is striking proof of that universal desire for liberty of thought which all the power of the Gestapo will never entirely stamp out.

"It will take a long time for the civilised Powers to repair the trail of material and moral havoc which Germans leave behind them. It will require all the resources of science. But I look forward to the day when the scientists of every nation can devote all their energies to the common task, and I wish you every success in the work that you are undertaking now."

The Foreign Secretary's Statement

At a luncheon given to the delegates to the Conference by the British Council on September 25, Mr. Anthony Eden, Secretary of State for Foreign Affairs, said that there was never a more appropriate time for such a conference: the representatives of the free scientific spirit from many lands were in Great Britain—and here of their own free will. They were to discuss what kind of world will be created when Hitlerism is destroyed. In recent generations science has set free new powers for our use, and, if we so determine, for our incalculable good. But lately, in the hands of evil men, these powers have been used to destroy all that is good in order to dominate and enslave all that is humane. No one action can more clearly reveal the present German spirit than the replacement at the University of Heidelberg of the inscription, "To the living spirit", by "To the German spirit". This German spirit has made German scientists slaves of the regime, and opposed to all that science represents. That spirit must be overcome.

We have called on men of science, Mr. Eden said, in the cause for which we are fighting. We shall need them no less in the cause for which we are working in peace. The advent of the machine has brought great material gain, but it has brought its terrors also. It has brought astonishing material advantages to many, but it has led to inequalities, to much selfishness, to unfair division, and to materialism. If after the War we are to remove the fear of want as well as of war, science and statecraft must work together. "In war-time, diplomacy is the servant of strategy. In peace-time I pray that it may be the servant of science."

New Hawker 'Hurricane' Aircraft

INFORMATION recently released upon the Mark II type of this aeroplane is of a certain technical interest. It has become a general fighter in use, and, as such, has now been fitted with a new series Rolls-Royce engine with a two-speed supercharger. This gives improved speed and climb at greater altitudes, while maintaining its good performance at lower heights. The principal change is in its armament, which is now four 20-mm. cannon or twelve machine guns, in the place of the original eight machine guns. The twelve machine gun type with improved performance is intended for dealing with enemy fighters when 'in-fighting', at short range. For this a maximum deluge of bullets for a short period is needed, while the enemy machine is in range. The cannon type is better for attacking the comparatively slow-moving bomber, shipping, or ground targets. The small individual shells are more effective against this type of target when a hit is scored, and the chances of hitting are sufficiently good as the target is comparatively slow in manœuvre, and can be kept in range more easily. Cannon fire is able to destroy enemy aircraft on the ground, armoured vehicles, and even small ships, against which machine-gun fire has been found to be not very effective. In the United States the opinion is held that even larger cannon, 37-mm. type, should be used. The heavier ammunition needed means that a smaller number of shells can be carried, and that the rate of fire is slower, but it is considered that the greater and more widespread damage from the larger shell, when it does score a hit, more than compensates for this.

Wind and Tide

To the layman, the exploitation of natural resources that are now going to waste may appear a good opportunity of getting power cheaply. To the engineer the obstacles in the way of their economic application often appear well-nigh insuperable. Thus the proverbially fickle wind has rarely been regarded seriously for the generation of electricity on any appreciable scale. This is not the opinion of the Central Vermont Public Service Corporation which, according to the *Electrical Review* of August 22, is connecting to its 44-kv. system a 1,000 kw. 2·3 kv. wind-driven alternator, said to be the first of its kind. In describing the equipment *Power* states that the plant, which is installed at a height of 2,000 ft., is expected to run for about 4,000 hours in the year, nearly three-quarters of the time on full load. Possibly the most important feature of the station is its association with a wind-power research laboratory, in which fundamental and engineering knowledge can be gained for the economic design and construction of wind-driven generating units in the future. In contrast to the erratic behaviour of the wind is the exactly predictable ebb and flow of the tide, which in this respect has an advantage over waterfalls that depend upon seasonable and weather vagaries. Its punctuality is not enough, however, to compensate for its intermittent action, and so a purely tidal scheme would have to be debited with the standing charges on steam plant required for filling in the valleys.

It was estimated to be much less expensive in overall costs to provide 550,000 kw. by steam plant than to harness the River Severn for the purpose. Only by virtually changing the scheme to a more ordinary hydro-electric lay-out could power from the tide compete with coal for generating electricity; that is, by using a large proportion of the tidal energy to pump water to a reservoir for driving other turbines in the slack periods. A similar idea was behind the Passamaquoddy project for producing 80,000 kw. from the River Maine. Even then production cost has been estimated at nearly twice that obtainable with a modern steam plant. As an addendum to his report to the United States Federal Power Commission, the chief engineer, Mr. R. B. McWhorter, envisages an elaborate seventeen-project programme, of which Passamaquoddy would form a part, in which case the cost per kwh. would be substantially less than that obtainable with steam. A great handicap to the development of tidal power is the length of time involved in construction—in the case of the Severn Barrage the capital expended would be unremunerative for about fifteen years. Moreover, contingencies are less easily covered by a reasonable percentage than they are with thermal stations. The favourable margin shown by the British scheme in comparison with steam will have increased materially since the report was published eight years ago. Much would depend on the value of improved road connexions between England and South Wales with which the proposals were associated, but unless some improvement is to be anticipated in the coal position after the War, the report might well be re-examined in the light of more recent developments.

Technical Bibliographies

DURING the past ten years the staff of the Sheffield City Libraries have compiled a number of bibliographies on technical subjects of special interest to research workers and technical staffs of local firms. In the compilation of these bibliographies expert help has been enlisted where necessary, and the collaboration between trained bibliographers and technical specialists has resulted in the production of a very useful series of reference lists, each relating to one specific subject and including papers and articles from technical periodicals as well as books fully or in part concerned with the subject. The fact that all the references can be consulted in the Sheffield City Libraries is a great convenience to local students and workers, although it naturally robs the bibliographies to some extent of completeness. Perusal of typical lists shows, however, that this lack of completeness does not detract substantially from the value of the compilations, a testimony to the thoroughness with which the City Librarian has catered for the needs of local industries in his acquisition of books and periodicals.

Since the outbreak of the War this bibliographic work has found and met an increased demand; an extensive annotated bibliography on steel sheet and strip issued in three parts has been in particularly heavy request from other parts of Great Britain and from overseas. Encouraged by this demand from a wider area, the City Librarian has prepared a list of recently compiled bibliographies; the subjects at present available include: acid tanks; austenitic steels; auto-frettage process; bending, straightening and reeling of steel; bonus systems; cold drawing of steel; cold heading of steel; cold pressing: colloidal metals; colouring of metals; decarburization of metals by hydrogen; electrolytic pickling and polishing; extrusion of steel; fatigue of metals; fluorspar-froth flotation; ingots: segregation and crystallization; patents on rock drill bits; manufacture of steel tubes; polarography; riveting of steel; rolling mills; spinning of steel; steel manufacture and properties; sulphur and phosphorus determination in iron and steel; tool steels; vertical boring mills; workshop practice and machine tools (books only). Applications for copies of any of the lists should be sent, with 3*d*. to cover postage, to the Central Library, Sheffield, 1.

The Lister Institute of Preventive Medicine

THOUGH damaged on two occasions and partly evacuated, the Lister Institute of Preventive Medicine has spent an active year, as shown by its annual report. As usual, the work has covered a wide field, including studies on antigens, phosphorylation in osteoid tissue, fat metabolism, and mucolytic enzymes. The Division of Nutrition, working at Cambridge and East Malling, has continued its vitamin studies. The Cambridge group has in particular investigated the nutritive value of different portions of the wheat grain and has been instrumental in recommending the use of 85 per cent extraction flour with added calcium for bread-making; the national wheatmeal flour is of this extraction, but the decision to add calcium to it has not yet been taken. The nutritive value of yeast has also been investigated, and this work is of particular importance since it is easy to grow yeast on certain waste materials, thereby providing a human food rich in first-class protein and vitamins of the B group. Dr. Zilva, at East Malling, has continued his work on vitamin C.

The Henry Lester Institute of Medical Research

The Henry Lester Institute of Medical Research, Shanghai, has also recently issued its annual report, and this shows that all activities have had to be restricted owing to the war in China. Studies on nutrition occupy a large part of the report, and Prof. Earle, who has recently been visiting Great Britain, states that "it is remarkable how many clinical signs and symptoms among Chinese patients can now be explained in terms of vitamin and mineral deficiency". Apart from many cases of two classical deficiency diseases—beriberi and pellagra—it has recently been found that ariboflavinosis is very common among the Chinese: more than a hundred cases were investigated during the latter part of the year. Deficiency of riboflavin is the latest recruit to human deficiency diseases, and has been shown by Sebrell to be surprisingly common in the United States. The condition, which includes eye and mouth lesions, undoubtedly occurs also in Great Britain.

Winter Wheat Seed

THE Council of the National Institute of Agricultural Botany, Cambridge, has decided to offer for sale about a hundred quarters of Steadfast, a winter wheat bred by Prof. F. L. Engledow, of the Cambridge University Plant Breeding Institute. Hitherto the wheat has been grown in the Institute's trials under the number 198 (20c). Orders are invited from members of the Agricultural Seed Trade Association, National Association of Corn and Agricultural Merchants, National Association of British and Irish Millers, and other established dealers in seed corn. Steadfast is the outcome of a cross between Little Joss and Victor, and as regards general habit, growth and type of ear is intermediate between the parent varieties. It possesses the excellent tillering properties of Little Joss, and ripens at the same time, and requires the same seed rate. The straw is shorter and its resistance to lodging is superior to that of Little Joss, but it has the same resilience and excellent thatching and feeding properties of that variety. As regards milling quality, Steadfast approximates the bread-making value of the 'softer' English wheats; it does not attain the exceptional quality of Yeoman or Holdfast. It is particularly suited to light and medium soils, but also thrives on the Black Fen, where its resistance to yellow rust will be specially valuable.

A Film Studio Electrical Installation

MR. F. V. HAUSER, chief engineer of two studio groups at Denham (Uxbridge, Middlesex) and Pinewood (Iver, Bucks), comprising twelve stages with a plant capacity of 7,000 kw., recently gave an illustrated lecture about studios to the Association of Supervising Electrical Engineers in London. Confining his detailed description to the Pinewood installation, Mr. Hauser said that the maximum electric demand for studio photographic purposes approximated to 2,000 kw. As D.C. at low voltage is necessary for arc lighting, five electric diesel generators totalling 2,360 kw. have been installed with three-wire distribution at 230/115 v. for studio lighting and at 230 v. only for all other purposes. To reduce noise and vibration, the engine foundations were formed of single island rafts of concrete 2 ft. thick, set 9 ft. below floor level and covered with a 2·5 inch sandwich of 'Coresil' cork on which rested a common concrete block 7 ft. deep, the whole weighing 1,000 tons. The insulating air space around the foundation is 9 in. wide.

To minimize voltage ripple (hum) interfering with sound recording, the generators have graded air gaps, specially shaped pole faces and skewed armature

slots, so avoiding the expense of heavy smoothing choke coils in main feeders and individual arc lamp circuits. The studio switchboards (four 3,000 amp. and three 5,000 amp. panels) and distribution features include bare aluminium ring mains (19,500 ft., weighing nearly 34 tons) supported by 'Sindanyo' racks attached to the roof steelwork, descending in sheet steel conduit to distribution boards at floor level, which are equipped with audible and visible signals for the overhead distribution 'grid' attendants. The object is to keep the floor free from trailing cables and feeding points, lighting equipment being stored overhead in the grid for quick lowering. Master control is exercised within the studio from a mobile desk on castors, plug-connected by a fifty-line multiple cable.

Recent Earthquakes

THE Jesuit Seismological Association at Saint Louis, U.S.A., has determined tentatively the epicentres of three recent earthquakes. From the readings of seismograms from eight stations the earthquake of June 27 at 17h. 11m. 30s. G.M.T. was found to have an epicentre near 16° N., 93° W., which is south-west of La Concordia in southern Mexico. By the Brunner chart the depth of focus was estimated to be 200 km., which is somewhat unusually deep for the fairly frequent normal and intermediate earthquakes in this area. From the readings of seismograms from sixteen stations the earthquake of July 1, at 7h. 50m. 57s. G.M.T., was found to have an epicentre near 34·4° N., 119·5° W. Damage by this earthquake was done in and about Santa Barbara, California, and the agreement is good. From the interpretations of records from ten seismographic stations the epicentre of the earthquake of July 3, at 7h. 11m. 51s. G.M.T., was found to be near 31° S., 68·7° W. This earthquake was felt at Mendoza in the Argentine Republic.

On August 15, a strong earthquake giving a full suite of pulses was recorded at Kew Observatory. The preliminary pulses registered at 6h. 16m. 45s. G.M.T., S at 6h. 22m. 42s., M at 6h. 29m. 34s. and the earthquake finished recording at 10h. 10m. having lasted nearly four hours. The maximum ground amplitude at Kew was 82μ and from the above tentative interpretation of the record the epicentre has been estimated to have been 4,330 km. distant from Kew.

Disease in New South Wales

ACCORDING to Dr. E. Sydney Morris, director-general of public health of the State of New South Wales, the chief event in the State since 1875 has been the rapid growth of Sydney, so that though the State is about 95 per cent rural the population has become increasingly urban. In 1939 the population was 2,749,134, of whom 1,380,940 lived in the metropolitan area of Sydney. Since 1875 the mortality from tuberculosis in New South Wales has dropped steadily, whereas the cancer mortality has increased at nearly the same rate. In 1875 the tuberculosis mortality was 154 and the cancer mortality 31 per 100,000 population. In 1895 the rates were respectively 109 and 44, in 1935 they were 105 and 39, and in 1939 tuberculosis fell to 37 and cancer rose to 113. The mortality from heart disease has shown an enormous rise in recent years. In 1875 it was 79; it fell to 57 in 1893, and has since risen, at first slowly and then rapidly, to 259 in 1939. As regards infectious diseases, influenza showed a mortality of about 5 until the great epidemic of 1891, when it rose to 87: it dropped to 8 in 1893 and 5 in 1917. In 1919, it rose to 319·3, and in 1920 it fell again to 18. Since then it has shown abrupt rises and falls. In 1899, when the incidence of scarlet fever was the highest on record (48·5 per 10,000 population), the mortality from this disease (2 per 100,000) was the lowest recorded until then. The mortality from measles has shown a great reduction in the height of the peaks since 1915 and a smaller incidence in the intervening troughs.

Population of Sweden

ACCORDING to preliminary estimates of the Central Office of Statistics, the population of Sweden in 1940 was 6,370,964. Comparison with the figure at the end of 1939 shows that the population has increased by about 30,000, corresponding to 4·68 per thousand. The growth of the population was split up as follows: 1,648 in the country, where there are at present 3,990,114 inhabitants, and 27,977 in the towns, where the population is now 2,380,850. Preliminary statistics for births and deaths during the past year show the following figures: 95,457 births and 72,584 deaths, that is, a surplus of births of 22,873, of which 12,927 were in the country. Lastly, there were 6,870 immigrants and 3,186 emigrants, giving a net surplus of 3,684.

Announcements

IT has now been announced that Prof. L. G. M. Baas-Becking, who was placed in custody in a prison in Scheveningen, Holland (NATURE, May 17, p. 606), has now been released by the German authorities and has assumed again the directorship of the Botanical Institute of the University of Leyden.

THE Joint Committee for Scientific, Technical and Engineering Supervisory Staffs, of 30 Bedford Row, London, W.C.1, has arranged a meeting and exhibition of technical films chosen to show the applications of scientific and technical advances in industrial processes, to be held at the Portland Hall, Little Titchfield Street, London, on October 11 at 3 p.m.

THE library of the University of Louvain, which was damaged in the War of 1914–18 and rebuilt largely through American generosity, was again destroyed in May 1940. Of the 900,000 books only 15,000 survive, of 800 manuscripts only 15; 3,000 collections of periodicals were completely destroyed by fire, likewise 811 incunabula and 200 valuable engravings, including some by Dürer and Holbein and 22,606 photographs of all known Coptic manuscripts.

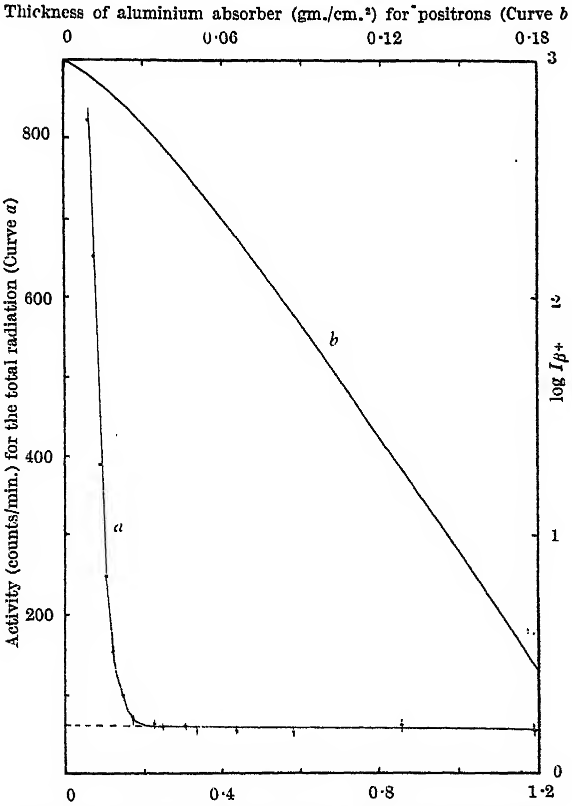
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Deuteron-Tritium Reaction in Fluorine

IT was shown in a recent paper[1] that the 'deuteron-tritium' (d, ^{3}H) reaction was responsible for the formation of ^{62}Cu, ^{106}Ag and ^{120}Sb by deuteron bombardment of copper, silver and antimony respectively. The same reaction is known to occur in beryllium[2] and nitrogen[3]. It therefore seemed desirable to look for other examples of this reaction. It has now been established that the (d, ^{3}H) reaction takes place in fluorine also.

Sodium fluoride was bombarded with deuterons of 9 Mev. energy and a lanthanum fluoride separation was made from the irradiated sample. The fluoride fraction showed, in addition to a short-period activity, an intense positron activity decaying with a period of 112 ± 2 minutes. The absorption curve in aluminium for the total radiation is shown in Fig. 1 (Curve a). The logarithmic absorption curve for the positrons obtained after extrapolation and subtraction of the annihilation radiation background is represented in the graph by Curve b. By comparing this curve with that for the β-rays of radium E, one obtains an absorption limit for the positron spectrum



Thickness of aluminium absorber (gm./cm.²) for the total radiation from ^{18}F (Curve a).

Fig. 1.

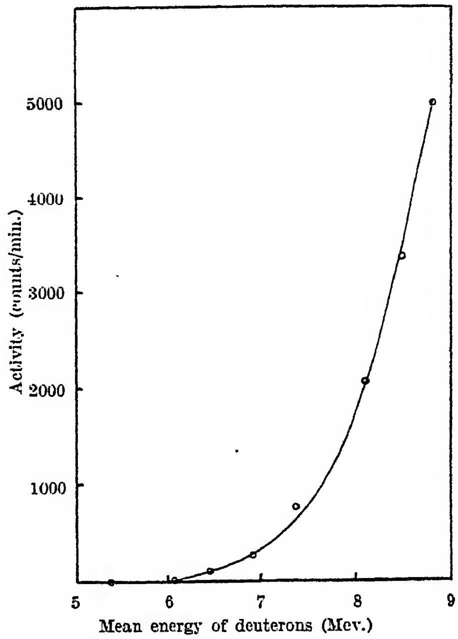


Fig. 2.

EXCITATION FUNCTION FOR THE FORMATION OF ^{18}F.

equal to $0{\cdot}23 \pm 0{\cdot}01$ gm./cm.^{2} of aluminium, corresponding to a maximum energy of $0{\cdot}72 \pm 0{\cdot}02$ Mev. Thus the properties of this radio-element are identical with those of the well-known ^{18}F [4] and should therefore be attributed to the same. ^{18}F is known to be formed from fluorine by the (n, $2n$) reaction. Control experiments which were carried out in order to establish that in the present experiments the 112-min. fluorine activity was formed directly by the action of deuterons, showed that the background neutron effect was negligible. ^{18}F is formed from fluorine under deuteron bombardment by the reaction

$$^{19}\text{F}\ (d,\ ^3\text{H})\ ^{18}\text{F}.$$

Excitation function measurements were made using the powder technique. Targets were prepared by spreading equal quantities (7 mgm.) of pure sodium fluoride as uniformly as possible over an area of 1 sq. cm. on thin copper foils. The layer of powder was fixed in position by the addition of a few drops of a solution of cine-film in amyl acetate. In each case a copper foil of 0·35 mgm./cm.^{2} thickness covered the deposit. Targets so prepared were bombarded separately with deuterons of different specified energies for five minutes each, keeping the beam steady during each run but not necessarily at the same value for all the runs. Aluminium foils were used when deuterons of less than the maximum energy were required. After bombardment, the sodium fluoride was dissolved in water and a lead

fluoride separation was made. The precipitate was washed well and dried. Correction was made for any loss of material that had taken place during chemical separation by weighing the dried precipitate. The activity of the lead fluoride precipitate was measured two hours after the end of bombardment and its subsequent decay was followed. From the family of decay curves the energy-yield curve for the 112 min. positron activity was determined and is reproduced in Fig. 2. In most cases the points plotted represent the means of three separate bombardments at a single energy. The threshold seems to lie at about 6 Mev. Assuming the known masses of ^{18}F and ^{19}F, calculations were made, and a Q value of $-3 \cdot 25$ Mev. was obtained for the (d, ^{3}H) reaction in fluorine. Because of the low probability of escape of the ^{3}H particle from the compound nucleus, no appreciable yield of ^{18}F is obtained for deuterons of energy less than 6 Mev.

The cross-section for the formation of ^{18}F from fluorine under deuteron bombardment was measured. For deuterons of energy 8·8 Mev., the value of the cross-section is $3 \cdot 9 \pm 0 \cdot 4 \times 10^{-27}$ cm.^{2}.

Dr. T. E. Banks and Mr. J. Dainty rendered me assistance in running the cyclotron.

R. S. Krishnan.

Cavendish Laboratory,
Cambridge.
Sept. 1.

[1] Krishnan and Banks, *Proc. Camb. Phil. Soc.*, 37, 317 (1941).
[2] Oliphant, Kempton and Rutherford, *Proc. Roy. Soc.*, A, 150, 241 (1935); O'Neal and Goldhaber, *Phys. Rev.*, 57, 1086 (1940).
[3] Borst, *Bull. Amer. Phys. Soc.*, 16, 35 (1941).
[4] Dubridge, Barnes, Buck and Strain, *Phys. Rev.*, 53, 447 (1938); Pool, Cork and Thornton, *Phys. Rev.*, 52, 239 (1937); Yasaki and Watanabe, NATURE, 141, 787 (1938).

Reproduction in Capuchin Monkeys

So little is known of the reproductive processes of any South American monkey that additional data on the typical genus Cebus are worthy of record. Capuchins seldom breed in captivity, only three records during a hundred years being given for the London Zoo by Zuckerman[1] and no further cases being mentioned in his revised report of 1937[2]. Since that date Hamlett[3] has given a detailed account of the œstrous cycle, ovulation and menstruation in Cebus, but he left many questions unanswered.

The present notes are based upon observations made on two male *C. xanthosternos* mated with three female Capuchins—two *C. vellerosus* and one *C. apella*. All three females have recently given birth to hybrid offspring.

Copulation, which Hamlett never saw, was inferred by him to occur at day-break, or some time before the arrival of laboratory staff, as it "seems unlikely that the monkeys copulate at night". With my animals copulation only occurred at night, usually at dusk. It differs in several ways from the process in Old World monkeys (a) in being very prolonged—up to twenty minutes in duration; (b) in the extraordinary vocal sounds accompanying the performance. These sounds are emitted by both participants and were echoed by an older (half-grown) baby living in the same cage. Copulation takes place *a posteriori*, but the male has long intervals of quietude during which he sits back without withdrawal, though continuing the vocalization. Restriction of copulation to certain periods of the menstrual cycle has not been noted, though this may be possible. No externally visible sign of menstruation has been observed in any of the females.

Gestation is probably of similar duration (that is, six months) to that of Old World monkeys, since one female *C. vellerosus* produced her offspring exactly seven months after first introduction to a male *C. xanthosternos*. Sexual behaviour was observed after the first three weeks.

The new-born differs from that of Old World monkeys in clinging to the mother's back, nuzzling its way round to her breast only at feeding time, thereafter returning to her back, clinging with its arms around her neck and its legs around her flanks. It does not use its tail for aiding its hold. The dorsal position is maintained from the first day.

The placenta is evidently eaten, since no sign of it was to be found within a couple of hours of birth, which occurred in one case in the day-time.

The three babies, despite their differing parentage, are all remarkably alike, and differ equally from either parent. They are all brown-bodied and black-limbed. The head pattern consists of a dark, almost black, oval central patch with a light, almost white, area on either side. The hair is long and soft on the head, not short and stiff like the father's or long and upstanding like the mother's. The body hair is lank and of the same texture as the mother's, so that the baby passes unnoticed except at close quarters.

Another curious feature is the extraordinarily rapid growth of the young compared with the tardy growth of Old World monkeys. The oldest baby was as large as its mother (*C. apella*) at the age of six months, and continued to grow after that, though it has not attained at the age of a year so great a size as its father, which belongs to a larger species.

A more complete account will be published elsewhere when circumstances permit.

W. C. Osman Hill.

Medical College,
Colombo.
July 7.

[1] Zuckerman, S., *Proc. Zool. Soc. Lond.*, 716-17 (1930).
[2] Zuckerman, S., *Proc. Zool. Soc. Lond.*, 321 (1937).
[3] Hamlett, G. W. D., *Anat. Rec.*, 73, 171-87 (1939).

Electron Energy-Levels in Biochemistry

The lecture of Szent-Györgyi, recently reported in NATURE[1], prompts us to publish some of the results we have accumulated on the electric conductivity of wool and other materials.

Dry wool shows strong polarization under an applied potential, but as its regain* is increased its conductivity increases exponentially and the polarization is gradually swamped. When its regain exceeds 6–8 per cent it appears to behave as an electronic semi-conductor: the polarization has disappeared and Ohm's law is obeyed[2], and the conductivity has a large positive temperature coefficient when the regain is kept constant. The temperature coefficient is, in fact, three times that of liquid water[3], and appears to be independent of regain above values of 6–8 per cent. When the logarithm of the conductivity is plotted against the reciprocal of the absolute temperature a straight line is obtained, and the slope

* Regain is the percentage moisture content calculated on the dry weight.

of the line corresponds to an activation energy of 1·3 electron volts. This energy is little influenced by ionic impurities, or by the electrodes used to measure the conductivity. If the water is replaced by methyl alcohol, the conductivity phenomena remain unchanged except that the activation energy is lowered to 1 electron volt.

These facts make it difficult to identify the electric conductivity of wool with ionic conductivity, whilst they do appear to fit readily with the hypothesis that the wool-water and wool-methyl alcohol systems are electronic semi-conductors; or that there are electronic energy bands in the system which are separated from the ground-levels by forbidden zones.

The conducting system seems to be the water or methyl alcohol appropriately adsorbed on a surface. This was tested by a study of the conductivity of glass surfaces. These show the same variation of conductivity with relative humidity of the surrounding atmosphere, and with temperature, that other fibres show. The activation energy is 1 electron volt, but otherwise the electric conductivity of glass surfaces appears to be the same as that of wool. The energy band system is therefore a property of suitably adsorbed water molecules. Water molecules adsorbed at interfaces must be common in biochemistry where cell wall surfaces are abundant, and it may be that electronic transfer of energy takes place along layers adsorbed at these interfaces.

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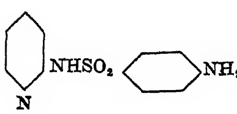
A. B. D. CASSIE.
Wool Industries Research Association,
Torridon, Headingley,
Leeds, 6.
Aug. 29.

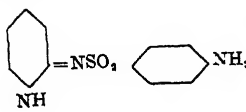
[1] NATURE, 148, 157 (1941).
[2] Marsh, *Trans. Far. Soc.*, 29, 173 (1933).
[3] Dorsey, "Properties of Ordinary Water Substances", Reinhold Publishing Corpn. (1940), p. 374.

Constitution of a Sulphonamide

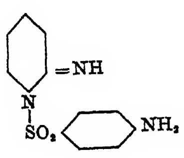
Crossley, Northey and Hultquist[1] consider that 2-(*p*-aminobenzenesulphonamido) pyridine has the constitution I below and not II or III mainly on the grounds that it is unchanged after prolonged boiling with concentrated caustic alkali solution.



I



II



III

This stability to caustic alkali[2] appears to me to be evidence against formula III and this view is supported by the synthesis of this sulphonamide from 2-halogeno pyridines and *p*-acetamido or *p*-amino benzene sulphonamides by the Ullman method[3]. The possibility, however, that this compound is a tautomeric mixture of the forms II and III must not be overlooked. Further evidence for the above view is afforded by the behaviour of 2 (*p*-aminobenzenesulphonamido)-pyridine on treatment with chloroacetamide in alkaline solution when *p*-aminobenzene sulphonyl α-pyridylglycineamide is obtained. This, on hydrolysis with caustic alkali gives *p*-aminobenzene sulphonyl α-pyridylglycine which on further treatment with hot dilute mineral acids gives the hitherto-undescribed α-pyridylglycine. This is a well-defined substance very soluble in water and sparingly soluble in alcohol; these characteristic glycine-like properties are quite different from those of the well-known isomeric compound, α-pyridoneimide-N-acetic acid obtained from α-amino-pyridine and chloracetic acid[4].

This latter compound on decarboxylation is known to give N-methyl-α-pyridoneimide; the interrupted study of the properties of α-pyridylglycine, including its de-carboxylation, will shortly be resumed.

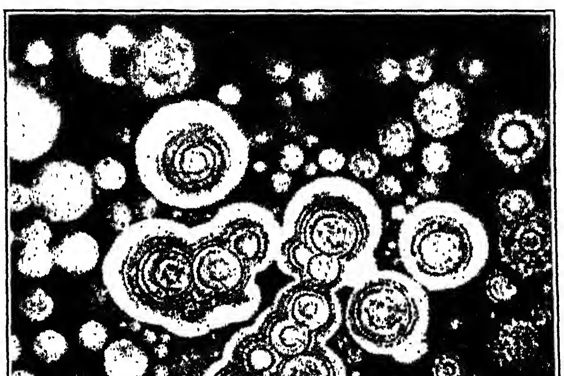
M. A. PHILLIPS.
May & Baker, Ltd.,
Dagenham,
London.
August 25.

[1] *J. Amer. Chem. Soc.*, 62, 372 (1940).
[2] See, for example, Phillips, *J. Chem. Soc.*, 10 (1941).
[3] Phillips, *loc. cit.*; English Patents Nos. 512145 and 530187.
[4] Tschitschibabin, *Ber.*, 57, 2092 (1924); Reindel and Rauch, *ibid.*, 58, 393 (1925); 59, 2921 (1926).

'Onion Skin' Structure of Carbonyl Iron

THE 'onion skin' structure of carbonyl iron is well known to those who are familiar with powder metallurgy technique. W. D. Jones in his book "Principles of Powder Metallurgy" states that this structure is probably due to interruptions in the decomposition of iron carbonyl vapour.

Recently while examining a pressed compact of carbonyl iron we came across a remarkably fine



× 1250

specimen of 'onion skin' structure which was revealed after the usual metallographic polishing followed by etching in 1 per cent Nital. The accompanying photograph shows the structure observed.

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E. V. WALKER.

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Post Office Research Station,
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Aug. 26.

Measurement of Physical Fitness

IT is desirable to direct attention, once again, to the need for devising and standardizing an objective measure of physical fitness.

The advantages which would result from the employment of a method of assessing the fitness of physique independently of subjective impressions have long been recognized. Little, if any, consideration has, however, been given to the following aspects of the problems involved.

The grading of recruits to the Services in the pre-enlistment medical examination is, as is well known, to a very large extent over-determined by subjective, qualitative impressions. Cases occur in which initial grading is too high and de-grading has to take place after the soldier has spent some time in a unit for which he is unfit. Many cases occur, no doubt, in which grading is too low. Statistical considerations alone lead one to suspect that there must be great regional differences in the proportions allocated to given medical categories and in the proportion of total rejects in any area. One may suppose that some physicians, not unnaturally, lower their standards of grading in order to provide more front-line men, and the effect is to give too generous a picture of health and virility in the men whom they examine.

There are in existence techniques of assessing physical fitness which, although admittedly subject to improvement, would nevertheless almost certainly add to the validity of the current qualitative procedures and act as a check on their accuracy. Moreover, it should be possible to raise the value of the qualitative estimates by appropriately weighting the constituent elements, for example, sensory acuity, or cardiac condition, according to their regression on physical fitness as measured independently. The statistical problems are very similar to those that arise in the marking of scripts in examinations.

The time is surely ripe for a survey of fitness in the army at different age-levels. It is not unreasonable to attach a biological validity to the concept of physical fitness and to regard it as connoting the 'integrative action' of the organism as a whole, resulting from the efficient functioning of the component physiological processes, the neuro-muscular system, the endocrines, the sense organs and so forth. Apart from social and economic disturbances in selection, physical fitness so defined and measured should, in theory, approximate to a normal distribution. Indeed, the concept is analogous to the notion of general ability as measured by psychological tests. The former should be both easier to measure and possess greater validity.

Such an investigation as is here proposed would provide information on the effects of different periods and types of training upon physique. Furthermore, since the medical history of each soldier is known, much would be added to our knowledge of constitutional predisposition to disease. From the eugenic point of view alone the task is worth undertaking.

JOHN COHEN.

A Peculiarity in Rainfall Variability

A SOMEWHAT perplexing and highly interesting peculiarity in the regimen of rainfall variation is this: all over the world, there is a much greater degree of uniformity in the relative variability of annual rainfall expressed as a percentage of the normal than in the absolute variability expressed as the actual deviation from the normal in inches or millimetres. As regards Great Britain, the late Mr. Carle Salter pointed out in his "Rainfall of the British Isles" that though the percentage variability is rather greater in the dry eastern than in the wet western districts, it is of the same order of magnitude everywhere, which of course implies that the actual differences in the quantity of rain from year to year are much larger in the wet parts. In fact, the deviations in the actual amount of rain above and below normal increase so systematically with the rainfall itself that they swamp the percentage values and become quite useless in comparative statistics.

Take, for example, a plus or minus variation of only 10 per cent, which is almost equally common all over Great Britain: this signifies so large a difference as 20 inches of rain between the wetter and drier year at a place, say, in Cumberland, with an average rainfall of 100 inches, as contrasted with the trivial range of 4 inches at a place on the coast of Essex with an average of only 20 inches; whereas if Nature worked more nearly by the absolute rule than by the percentage rule, a 10 per cent variation at the drier place should be balanced by a 2 per cent variation at the wetter. Evidently, in the natural scheme a few inches more or less of rain a year which appear conspicuous at a dry place count for little at a wet place, and in dry and wet years the total rainfall is not lowered or raised by similar actual amounts everywhere but by similar proportional amounts.

The physical interpretation of the peculiarity is no doubt this: in places of heavy rainfall, any intensification or abatement of the normally acting factors is likely to produce a proportionately large effect in actual quantity of rain, which will not be the case in dry places, though in some parts of the world there are erratic dry climates where very exceptional years of abnormally heavy rainfall point to the operation of unusual factors.

In general, it is remarkable what little interest writers on rainfall statistics show in the dependence of actual variability on the rainfall itself, merely remarking on the convenience or necessity of working with percentage values, as though this dependence were axiomatic and there was nothing more to be said. The proposition, however, is not self-evident to the preclusion of physical discussion. Even V. Conrad, who in a paper published in the *Monthly Weather Review* of January, 1941, demonstrates mathematically the close relationship between absolute variability and the magnitude of the rainfall itself, does not pause to reflect why this should

be the case, but immediately goes on to show that the percentage method of studying rainfall variability which is a necessary consequence is not a perfect measure of true variability because at very low annual rainfalls below 10 inches, the percentage values change unduly rapidly with trivial differences in the rainfall itself.

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August 31.

The Relations between Science and Ethics

IT was an excellent idea to base a general discussion on the relations between science and ethics on Dr. Waddington's stimulating and lucid account of the subject[1]. What has been most striking about the comments which have been made on it is the failure which some of the commentators exhibit to understand his view of the nature of the evolutionary process. The persistent existence of the lowest forms of life (to which Prof. Ritchie directed attention), or the fact that parasites may achieve a high degree of adaptation to environment at the cost of profound degeneration, or the continuation of evolution (in Prof. R. A. Fisher's phrase) "in the teeth of a storm of adverse mutations", have nothing to do with the inescapable fact that, during biological evolution, the degree of complexity and organization has increased. With the appearance of man, the maker and user of tools, the speaker, the moulder of his surroundings, this process, the outward and visible sign of which has been a progressively greater independence of the organism *vis-à-vis* its environment, reached its culmination. Thinkers such as Herbert Spencer (whom some of the contributors go out of their way to attack), were perfectly correct in viewing social evolution as continuous with biological evolution. In social evolution we cannot but see a more or less continuous rise in level of organization parallel with the increasing size and complexity of human communities, culminating in the conception of the world co-operative commonwealth now dawning upon the minds of men. Though there have been backslidings innumerable, there have also been points higher than the main curve of human social evolution sweeping its way across the graph of history.

Some of the contributors seem to be still under the influence of the Darwinian preconception which saw nothing in animal life but the struggle for existence, a concept which, as Engels carefully pointed out, had been introduced from Malthus's analysis of the predatory characteristics of capitalist society. But there were others beside Spencer who showed the one-sidedness of the idea of Nature red in tooth and claw. Kropotkin pointed to the very value of animal associations in this struggle, and Henry Drummond (a much misunderstood thinker) successfully traced the beginnings of social altruism downwards to the numerous phenomena of parental care and even to the donation of part of the self for the succeeding generation in every reproductive act. Drummond even went so far as to say that the goal of evolution was love and the good life, an assertion which his biographer described as "grotesque", but which we can scarcely think so if we recognize, as we must, the highest levels of human co-operative social life as themselves the products of evolution.

This, I take it, is what Dr. Waddington means by saying that the evolutionary process itself supplies us with a criterion of the good. The good is that which contributes most to the social solidarity of organisms having the high degree of organization, which human beings do in fact have. The original sin which prevents us from living (in Prof. Joad's phrase) "as Christ enjoined" is recognizable as the remnants in us of features suitable to lower levels of social organization, anti-social now. There is, of course, the incidental difficulty of continually modifying the letter of the teaching of the great ethical 'mutants' to fit changing techniques and increasing knowledge without losing their spirit.

From this point of view, the bonds of love and comradeship in human society are analogous to the various forces which hold particles together at the low colloidal, molecular, and even sub-atomic levels of organization. Henry Drummond actually dared to say this. If such an idea is accepted, Prof. Joad's insistence that we must have some extra-natural criterion of ethical values ceases to have any point. The kind of behaviour which has furthered man's social evolution in the past can be seen very well by viewing human history; and the great ethical teachers, from Confucius onwards, have shown us, in general terms, how men may live together in harmony, employing their several talents to the general good. Perfect social order, the reign of justice and love, the *Regnum Dei* of the theologians, the Magnetic Mountain of the poets, is a long way in the future yet, but we know by now the main ethical principles which will help us to get there, and we can dimly see how these have originated during social and biological evolution. Prof. Stebbing is perplexed as to whether we ought to call evolution morally admirable or morally offensive; it is surely neither. The good is a category which does not emerge until the human level is reached.

For the benefit of Prof. Ritchie, I may add that whatever label or docket in Prof. Broad's book is attached to the views here expressed is a matter of relative indifference to me. They certainly cannot be called original. Many others have appreciated the emergence of ethical relationships and their interpretation in the light of scientific thought.

JOSEPH NEEDHAM.

Caius College,
Cambridge.

[1] NATURE, 148, 270 (1941).

A SCIENTIFIC statement is essentially an expression of relations derived from and applicable to experience: it is therefore easy to determine whether a statement is scientific or not by considering its relation to experience. Dr. Waddington's statement "The real good cannot be other than that which has been effective, namely, that which is exemplified in the course of evolution", is clearly not derived from experience, for it does not express anything found by observation. Nor is it applicable to experience; when we try to apply it to any actual ethical problem (for example, "Is it morally good to bomb German cities?") it is found to be useless.

I do not believe that Dr. Waddington intends to be among the apriorists, but actually his so-called scientific ethical principle belongs to the company of Eddington's inviolable laws and Milne's cosmological

principle. It provides one more example of the widespread abandonment of science in the name of science. HERBERT DINGLE.

Imperial College,
S.W.7.

Leadership of Science

THE leadership of science is vital to the preservation and rebuilding of civilization. No less vital, as the recent admirable editorials in NATURE have urged, is a unity of aspiration and effort on the part of the United States and the British Commonwealth of peoples. To create now a moral and intellectual unity of the English-speaking peoples is to lay the foundation of that mighty union of democracy, the prayer of Longfellow and the message of Roosevelt, upon which hangs age-long weal or woe for mankind. The leadership of science must exert itself most fruitfully when integrated with that immense work of political creation. Indispensable to such a synthesis is the saturation of the 'man in the street' with the spirit and aspirations of science, together with a lively comprehension in broad outline, of what it is doing from day to day. Not until science replaces football pools in popular interest will the common person be fit to sustain civilization or the men of science in a position to lead it. Notable work in popular education has been done by many gifted thinkers. But the situation calls for something more organized and comprehensive, corresponding to the world which science has brought into being, where continents and peoples are linked in ever greater interdependence.

Nothing less is needed than a pooling of the common stock of contemporary thought and achievement in science presented in a form assimilable by the common person.

But if science really does transcend frontiers, if Anglo-American unity is not a fantasy, why do we need dispersed and divided plans of educating the public in scientific matters just where the common approach bids to be most potent ? Why cannot British and American men of science give a lead to the spirit of union, to thinking in terms of 'us' rather than of 'we' and 'they', which, as rightly suggested[1], is more important than cut and dried schemes of amalgamation? Should not men of science be the first to give an example of "pooling experience for the growth of mutual understanding", to use NATURE's words ? Speaking for the common person, I say we want to know what American men of science are doing, as the common person in America doubtless wants to know the same of British men of science.

The collaboration of British and American men of science as a body in issuing a periodical publication, say, monthly, of scientific news and progress in popular form, is capable of becoming the greatest move ever made towards the enlightenment of humanity in the mass. The leadership of science in the direction of a world planned for freedom and abundance for all cannot afford to conceive its duty of education in relation to obsolescent conceptions of nationalist sovereignties. The man in the street, if he is to think at once internationally and scientifically, needs the assistance of a new sort of creative journalism which shares those qualities.

H. BREWER.

18 Langham Road,
Cambridge.
Sept. 7.

[1] NATURE, 148, 233, 263 (1941).

"The West Highlands and the Hebrides"

IN the review in NATURE of August 16 of the above book by Dr. Harker, which was recently published posthumously, attention is directed to certain omissions in a Table of Formations which was added to Dr. Harker's original manuscript. Perhaps I may be allowed to explain that the Table was drawn up as an adjunct to the stratigraphy as set out in the text, in order to serve as a handy means of reference for the non-professional reader, for whom the book was primarily written, and also for geologists not conversant with the local details. As a matter of fact, Dr. Harker found occasion in the text to refer to almost all the geological systems and their subdivisions, and in this way has drawn a picture of the stratigraphy which is essentially complete. Since he did not mention certain subdivisions of the Jurassic system which are represented somewhat meagrely, namely, the Kimmeridgian (which is specially referred to in the review), and the Corallian, Callovian and Cornbrash, these were purposely omitted from the Table of Formations. Similarly, the Durness Limestone was placed in the Cambrian, because this long-established British custom was followed by Dr. Harker in the text. It appeared to raise too many complications, and indeed to be unnecessary in this book, to direct attention to the fact that the custom requires modification.

May I take this opportunity to correct one omission ? The New Red Sandstone of Arran was not subdivided by Dr. Harker into Permian and Trias. It became necessary to do so, since a previously published map showing this differentiation was being used as an illustration of the geology of the island. A footnote on p. 7 was therefore added, in which a recent identification of Permian lavas was mentioned. It should have been made clear, since it has so happened that the publication of the book has antedated that of the research paper concerned, that the identification was made by Dr. D. Leitch, of the University of Glasgow.

J. E. RICHEY.

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Edinburgh.

Huygens' Pendulum Clock

THE interesting article by Mr. A. E. Bell on the "Horologium Oscillatorium" in NATURE of August 30 rather suggests that this was Huygens' first book on the pendulum clock. He published a description, with plates, of the clock in "Horologium" (The Hague, 1658) though without reference to the scientific principles. The book is very rare and is not generally known. Part 1 of the "Horologium Oscillatorium" repeats its contents.

Huygens' specially constructed marine clock was actually tried at sea, and received a favourable report. The report, by Major Holmes, "A Narrative concerning the success of Pendulum Watches at Sea for the Longitude", is in *Phil. Trans.*, 1, 13–15 (1665).

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TIN THROUGH THE AGES

AN EXPERIMENT IN MUSEUM SYNTHESIS

By Dr. F. J. North
National Museum of Wales

A GALLERY in the National Museum of Wales at Cardiff is used exclusively for temporary exhibitions, of which there may be three or four in any one year. The present exhibition, "Tin through the Ages in Arts, Crafts, and Industry", was designed to dispel the notion that because we describe an inferior musical instrument as tinny, and dismiss something paltry and ill-conceived as a 'tin pot' affair, tin is therefore a metal of no importance. The subject-matter has been so treated as to demonstrate the connexion between a great variety of apparently unrelated things, with the view of discovering continuing threads in the story of human progress ; this reverses the usual museum practice, which tends to emphasize the difference between groups of cognate objects and to confine synthesis to the material within a group.

A handbook* has been prepared to provide a running commentary to the gallery, but since it summarizes the story which each of the exhibits has to tell, without actually describing them, it will serve as an outline of man's indebtedness to one of the most useful of all metals, independently of the exhibition itself.

A gratifying feature of the exhibition has been the readiness with which (often in difficult circumstances) manufacturers have provided examples of their products and photographs of their plant. Half a dozen museums, too, have contributed material, and my own indebtedness to the Tin Research Institute is considerable.

The story begins with the minerals in which tin is present, and with comparisons between ancient and modern methods whereby they are isolated from their ores, but the major part of the exhibition is concerned with the utilization of the metal, its alloys and its compounds.

When man began to experiment with copper as a substitute for stone in the manufacture of weapons and tools, and realized that the presence of a certain other metal—we call it tin—produced something—we call it bronze—that although harder than copper alone was more easily cast and manipulated, he made a discovery which, by giving him better and more abundant implements, greatly accelerated the progress of civilization ; and tin has played an important part in nearly every subsequent development that has tended to widen man's physical and intellectual horizons.

Strangely enough, the range of articles made from tin alone has always been limited. A few ancient objects of cast tin have been found in Egypt, while collapsible tubes for tooth-paste and wrappers for cheese are made of pure tin, but its importance has always depended mainly upon its capacity for extending the applications of other metals. It is an essential, and often the principal, constituent of many alloys in addition to those included under the general name bronze : pewter, solder, printing metals, bearing metals, organ pipe metal, dental metals, and fusible alloys all owe their special characters in part or entirely to tin.

The Romans knew that a tin lining to vessels of copper or bronze made them more suitable as receptacles for food and water. This use of tin, which has continued throughout the ages and has been applied to iron and steel as well, depends upon its readiness to combine with other metals and its capacity for resisting corrosion, and it shows that the importance of the metal is not to be judged by the quantity that is used, for the coating of tin is exceedingly thin. In the common 'tin can', for example, the protective layer is no more than one ten thousandth of an inch in thickness, and all the advantages we derive from tinned foods (to mention only one kind of commodity that is put into tins) we owe to this extremely attenuated film of tin. That this thin film can be effective is even more surprising, when we realize the strains and stresses to which the tinplate is subjected in the machines that convert it into cans and in the plant that fills and seals them.

One exhibit shows that tin is the principal constituent of pewter, and specimens from Roman to recent times illustrate the way in which its different varieties have been cast, spun, or beaten into vessels for ornament and for use ; another, entitled "Tin in Printing", illustrates the role of tin in printing metals, since the invention of movable types began to make knowledge the heritage of the multitude instead of the monopoly of the few.

It is tin which determines the properties of the varieties of solder ; innumerable articles, affecting every phase of human life, are commercial possibilities because of the ease with which soldered joints can be made, and we owe the effective distribution of water, gas and electricity to the solder which ensures the continuity of the conducting elements. As with the other alloys, the past and present uses of solder are illustrated by specimens and photographs, and the metallurgical explanation of its behaviour is simply described with the aid of diagrams and photomicrographs.

Tin is an essential, although not usually an abundant, constituent in the so-called fusible metals. At one time they were curiosities, as when used for making spoons that melted in hot tea ; later they found practical applications in the sprinklers which caused water to be sprayed in a room where a fire had developed, and nowadays they are employed in many engineering processes, as for example, in bending thin-walled tubes, like those for conveying oil and water in aeroplanes : the tube is filled with molten alloy, bent after the metal has solidified, and then immersed in hot water or in a steam bath so that the alloy can be melted and drained away.

Of outstanding interest is the part which tin has played in 'bearing metals', since the days when it was realized that the development of frictional heat in an engine was diminished by the introduction of a lining

* "Tin through the Ages, in Arts, Crafts and Industry", Handbook to a Temporary Exhibition, July–December 1941, by F. J. North, (National Museum of Wales, Cardiff). Pp. 38. 3*d*.

or bearing of bronze where one metal part moved in close contact with another. Later on, other alloys of tin provided still better bearing metals, and nowadays some of them contain more than 80 per cent of tin.

Many uses have been found for compounds of tin, as, for example, in producing rose tints for ceramic decoration, the white background for majolica and delft, the glaze of modern sanitary fittings, and the enamel of refrigerators, thus adapting to modern requirements a practice dating back at least to Babylonian times.

The foregoing notes show that a heterogeneous collection need not of necessity be haphazard, for with specimens ranging from part of a Roman pump to an electric kettle, and photographs ranging from Egyptian tomb-pictures to a pea-cannery, it is possible to complement the more usual kind of museum exhibit, based upon a desire to separate things which belong to different ages, or were put to different uses. This aspect of the exhibition can be illustrated by reference to one section only, that relating to bronze: approach from an archæological point of view leads to exhibits showing the kinds of implements that Bronze Age man could make, how they were related in time, and how they became more and more efficient, particularly in the direction of better fixture to their hafts: here the museum story usually ends, for iron superseded bronze, and Iron Age cultures demand consideration, and that there is any connexion between the palstave and a machine-component cast in bronze does not appear.

When, however, we add to the archæological information what modern methods of examination have taught us about the properties of alloys, we realize that the improvements in early implements ran concurrently with man's increasing knowledge of the materials he used; we connect up the oldest of metallurgical practice with the newest of metallurgical theory and research, and in our stride we can take in all the things for which the varieties of bronze have been employed—bells and guns, statuary and friezes, measures and machine-parts, and even the wire cloth on which paper is made.

We find that although the modern foundryman can deal with tons whereas his predecessor could only handle pounds, the principles on which he works are just the same. Bronze Age man discovered the principles of all the methods of casting that are used to-day, and learned to make metal reproductions of his moulds that could be used again and again, thus speeding up production and ensuring uniformity of results. Nowadays permanent moulds are made of steel, not bronze, and powerful machines force the molten metal into cavities more complicated than the old-time workers either needed or could have made; nowadays we call it die-casting, but the principle is the same, and so are the advantages claimed—speed of production and uniformity of result.

The experiment seems to have justified itself because the archæologically minded visitor, caring little for modern machinery, has discovered that in his ancient bronzes he has the beginnings of a story that is still in the process of writing; and the engineer, not a whit interested in axes and palstaves, has found that when he tries out a new method for 'babbitting' a connecting rod, he is contributing to a story of which the opening chapters belong to a period so remote that they have to be reconstructed, not read.

An exhibition like this shows how arbitrary are the conventional dividing lines between cultural and academic studies on one hand, and science and industry on the other, and how unsubstantial are the lesser dividing lines within these groups. Material that one would expect to see in a 'trade show' is displayed in the same gallery, and often in the same case as the 'cultural' objects normally associated with a museum, but there is no apparent incongruity either in the arrangement of the specimens, or in the ideas they are intended to suggest.

Taking a dictionary definition of culture as "a state of intellectual and artistic development", it would seem that museums can do much to show culture what it owes to industry, and, by illustrating the methods and results of industrial research (not merely the products of industry), to show that industry is itself specialized culture, for as Pope once put it, all are, indeed, but parts of one stupendous whole.

EXHIBITION OF PHOTOGRAPHY

THE eighty-sixth annual exhibition of the Royal Photographic Society of Great Britain was opened at the Society's Galleries, 16 Princes Gate, S.W.7, on September 5, by the Right Hon. J. T. C. Moore-Brabazon, the Minister of Aircraft Production. This is the second exhibition that has been organized under war-time conditions, and it would be foolish to pretend that it has not suffered in any way.

The Pictorial Section is up to strength, and appears to have maintained its high peace-time standard of quality, and it is gratifying that even this year most of the Dominions and the United States are represented.

The Scientific Section unfortunately suffers from a marked absence of exhibits from abroad. Photography is much used in Great Britain for scientific and industrial purposes, but few examples seem to find their way to the exhibition. It is also regrettable that few university laboratories in the country carry out research directly related to photography, though they certainly make use of it as a tool. In past years exhibits from abroad, such as the illustrations of ultra-high-speed photography of Edgerton and Germeshausen, and illustrations of the use of photography in research on cosmic rays and atomic particles, have been a feature of the Scientific Section. However, apart from these absentees, all branches of the section are represented by exhibits of high standard. There are examples of both low- and high-power photomicrography, the latter being illustrated by two striking examples of diatoms.

The number of exhibits illustrating the use of photography in medical work clearly shows the value of this application of photography. Many of the photographs taken for demonstration purposes are made during the course of surgical operations, and the operator is beset with many difficulties, such as obtaining sufficient light and suitable modelling to show up the desired features without interfering with the course of the operation. Other examples show

the value of the combination of a schematic diagram of an organ and actual photographs of the object. The use of infra-red photography for rendering fine detail of structure in relatively thick sections of fossil stems of plants is illustrated by a number of examples.

Radiographs are well represented, the subjects being mainly of medical interest. The Rodman Medal, which is awarded for the best exhibit of a non-pictorial nature with special reference to radiography or photomicrography, has been given to R. M. Leman for his "Radiograph of Arum Lily" and "Radiograph of Larch". These were presumably taken with soft X-rays, and a relief effect has been obtained possibly by combining a positive and a negative of different contrasts and slightly out of register. The effect is certainly very pleasing from a pictorial point of view.

The remainder of the Scientific and Technical Section consists of a number of exhibits grouped under the name of "Survey and Record Photography". These are largely records of carvings, interiors of churches, etc., of which there are some excellent examples to be seen, and in these times such records assume a greater importance. The outstanding example of record work is the series of ten photographs, by H. Bedford Lemere, of famous London buildings, most of which have been seriously damaged by enemy action within the last twelve months. This exhibit has gained the Hood Medal. The Natural History Section is well filled and contains examples of all kinds, botanical, birds in their natural habitats (always a popular subject), and mammals, mainly feline, photographed in captivity. Natural history photography attracts a number of amateurs who master the technique of photography in order to apply it to their hobby. The pictorialist enjoys his search for good composition; the photographer of Nature gets his excitement in another way, an excitement akin to that of the hunter. There is a photograph of the grey hare appearing out of a burrow set in trackless wastes of snow, and one can imagine the preparation and care necessary to obtain such a photograph.

The Colour Photography Section has suffered seriously this year, which is scarcely surprising, considering the difficulty of obtaining colour film. The transparencies are chiefly taken with miniature cameras on Kodachrome, Dufaycolor and Agfacolor films, while the colour prints on paper are reduced to six examples, three each on Wash-off Relief and Tritone. The lantern slide exhibit is mainly confined to natural history subjects, and both these and the purely 'pictorial' slides are well worth seeing. The slides are mounted in viewing boxes in a darkened room, and clearly illustrate the advantage of the transparency over the paper print due to the greater range of tones that can be reproduced by the former.

In the opinion of many, the most effective photographic reproductions are to be seen in the stereoscopic section, which contains some hundred transparencies, of which about half are in colour. The combination of the extended tone reproduction of the transparency with the stereoscopic effect, and in some cases colour, can produce a realism that may not satisfy the modern pictorialist, but can be very attractive to those who like to see things as they are.

The Exhibition as a whole, which is open to the public daily (except Sunday) from 10 a.m. until 5 p.m. until October 25, is well worth a visit. Though there are some notable absentees among the regular exhibitors, the Ministry of Information has supplied a series of more than a hundred British official photographs illustrating some applications of photography in depicting various phases of the Navy, the Army, the Air Force, in the manufacture of munitions, in home defence, and for propaganda and Press purposes.

LIGHTNING OVER-VOLTAGES IN UNDERGROUND CABLES

The occurrence of lightning over-voltages on underground cables is ordinarily supposed to be impossible except when a cable is connected to an overhead line. In this case surges initiated in the latter may be propagated into the cable. In a recent paper by Dr. H. Einhorn and Prof. Goodlet of the University of Cape Town*, new facts are adduced which prove that the ordinary opinion is untenable. They describe some curious faults on underground telephone cables experienced during the lightning season in the vicinity of Johannesburg which cannot be explained in the general way. Briefly described, breakdowns occurred between the outer cores and the lead sheath and armouring of telephone cables buried to depths up to three feet in dry sandy soil. All the faults occurred during the lightning season, and faults were most frequent in the worst storm areas traversed by the cables.

In one case voltages up to 1,000 volts were measured (by electrostatic voltmeter) between cable-end and earth during a storm. The faults could therefore with certainty be ascribed to lightning; the potential of the cable sheath must in some manner become raised relative to the cable cores. The problem the authors set themselves is to find out how this occurred and investigate possible remedies.

Direct strokes to earth are first considered. If a lightning flash of current I strikes an overhead conductor of surge impedance Z somewhere in a span, a travelling wave of amplitude $\frac{1}{2}ZI$ is propagated along the line in both directions away from the fault. Our knowledge of the propagation of electric disturbances along bare buried conductors is not extensive but is sufficient to allow us to picture events as happening in a similar manner, modified by the considerable leakage into the ground. Tests indicate that if an impulse voltage is suddenly impressed upon a long buried conductor the "effective surge impedance" (defined as the ratio of instantaneous voltage to instantaneous current) will fall from an initial maximum value of the order of 100 ohms down to the ohmic earth resistance of the conductor.

The attenuation of waves along uninsulated buried conductors is very rapid, being usually complete in a distance of less than 100 m., so that reflexion pheno-

* *J. Inst. Elec. Eng.*, 88, Part 2, No. 4 (Power Engineering) (August 1941).

mena are seldom important. An impulse current fed in at one point of a buried conductor will therefore raise its potential to a maximum of about 50 kv. per kiloampere of current entering the conductor.

The formation of fulgurites proves that a lightning flash can penetrate a considerable distance into the ground, and therefore a direct stroke to a conductor buried only 2 ft. below the surface is not an impossibility.

Appreciable potentials may also arise due to earth-current voltage gradients if a flash strikes the ground anywhere in the vicinity of the cable. A similar effect has recently been investigated in connexion with power-system earth faults.

The increase of potential of the ground around substations, under fault conditions, is liable to cause breakdown of the dielectric of light-current cables entering the area when the cores of these cables are maintained at substantially earth potential. The cables can be protected against this hazard by insulating the sheath from earth for a certain distance from the substation.

The authors give a simple theory of the potentials induced on the ground-surface beneath a thundercloud. The separation of charges within the cloud surface occurs relatively slowly and is not accompanied by any sudden field changes at the ground surface. An approximate expression is found for the instantaneous value of the potential of the ground surface. If C is the capacity and R the resistance to earth of the ground surface, the product CR is constant irrespective of the distribution of the conduction and displacement currents in the ground.

An experimental arrangement of apparatus is then described showing the possibility of inducing potentials on buried conductors. A 12-stage 220 kv. portable impulse-generator is fed from a 200/30,000-volt single phase transformer with variable primary voltage over a half-wave thermionic rectifier. The impulses are applied over a water resister to a 2-ft. diameter metal plate, suspended above a bakelite cylinder filled with sand or garden earth. The crest value of the applied surge voltage is measured by means of 15-cm. remote control spheres. Embedded in the sand is a 9-in. brass disk connected to a 2·5 cm. sphere gap which is screened against the top plate and ionized by means of a mercury-arc quartz lamp.

Three different embedding materials were investigated: air-dried sand, moisture-content 0·05 per cent (by weight), specific resistance greater than 10^9 ohm-cm.; garden soil specific resistivity about 10^5 ohm-cm., and steam-wetted sand which had a resistivity of about 4×10^5 ohm-cm.

The conclusion is drawn that for dry sand the induced voltage is purely a matter of capacitances, and is practically independent of the wave front. With garden earth no effect due to the charging stroke could be observed within the possible working range. With steam-wetted sand the potential induced by the charging stroke was measurable and was clearly proportioned to the impulse crest voltage.

The theory given and the results of the experiments suggest that potentials can be impressed on conductors buried in the ground under a thundercloud and indicate an upper limit to their magnitude.

It is suggested that a cable laid in low resistivity soil will not experience induction trouble. Considerable attention should therefore be paid to soil aridity when choosing a cable route. Whether plant growth affects the moisture content of the soil to any appreciable depth is uncertain.

FORTHCOMING EVENTS

[Meeting marked with an asterisk is open to the public.]

TUESDAY, OCTOBER 7

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. V. Zachary Cope: "The Influence of War on Surgery".*

FRIDAY, OCTOBER 10

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 4 p.m.—Prof. J. T. MacGregor-Morris: "Recent Work on the Use of Photo-electric Rectifier-Type Cells in Photometry".

APPOINTMENTS VACANT

(not included in the monthly Books Supplement)

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LIBRARIAN—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (October 8).

LECTURER IN ELECTRICAL ENGINEERING SUBJECTS at the Cardiff Technical College—The Director of Education, City Hall, Cardiff (October 8).

ASSISTANT LECTURER IN GEOGRAPHY (MAN OR WOMAN)—The Registrar, University College, Nottingham (October 13).

HEADMASTER of Stockport Grammar School—The Clerk to the Governors, Stockport Grammar School, Mile End, Stockport (October 15).

CIVIL ENGINEERING ASSISTANT—The Clerk to the River Ouse (Yorks) Catchment Board, 7 Langcliffe Avenue, Harrogate (endorsed 'Engineering Assistant') (October 15).

INSPECTOR OF SCHOOLS (WOMAN)—The Director of Education, Guildhall, Hull (October 18).

LECTURER-IN-CHARGE OF MECHANICAL ENGINEERING—The Principal, Aston Technical College, Whitehead Road, Birmingham 6.

GRADUATE LECTURER WITH QUALIFICATIONS IN MATHEMATICS, PHYSICS, OR ENGINEERING—The Principal, Technical College, Kendrick Hall, Stroud, Glos.

REPORTS AND OTHER PUBLICATIONS

Great Britain and Ireland

Tin Research Institute. Publication No. 105: The Spectrographic Analysis of Tin-Lead Soldiers. By D. M. Smith. Pp. 8. (Greenford: International Tin Research and Development Council.) [179

British Rubber Producers' Research Association. Publication No. 11: Studies in the Sterol Group, 43: The Unsaponifiable Portion of the Acetone Extract of Plantation Rubber. By I. M. Heilbron, E. R. H. Jones, K. C. Roberts and P. A. Wilkinson. Pp. 4. Publication No. 12: On Measuring the Efficiency of a Tractor by its Fuel Consumption. By E. W. Russell and H. J. Hine. Pp. 13. (London: British Rubber Producers' Research Association.) [179

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 139: The Soils of Tasmania. By C. G. Stephens. Pp. 40. (Melbourne: Government Printer.) [179

Bulletin of the American Museum of Natural History. Vol. 78, Art. 2: Results of the Archbold Expeditions, No. 34: Development and Enemy Recognition of the Curve-billed Thrasher *Toxostoma curvirostre*. By A. L. Rand. Pp. 213–242. Vol. 78, Art. 3: New American Syrphidæ. By C. H. Curran. Pp. 243–304. Vol. 78, Art. 4: A Study of *Orycteropus gaudryi* from the Island of Samos. By Edwin H. Colbert. Pp. 305–352. Vol. 78, Art. 5: Results of the Archbold Expeditions, No. 35: A Review of the Genus *Hipposideros* with Special Reference to Indo-Australian Species. By G. H. H. Tate. Pp. 353–394. (New York: American Museum of Natural History.) [179

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NATURE

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MOBILIZATION OF MENTAL POWER

THE relatively late rise of psychology among the sciences is partly due to the fact that its subject-matter is so wrapped in prejudice and entangled in tradition that it is most difficult to examine in a detached and scientific spirit. The obstacles preventing the application of precise psychological information to personnel selection in the army, where tradition is so deeply entrenched, would seem to be particularly forbidding, and the Select Committee on National Expenditure is to be congratulated for devoting one of its reports to this topic*.

One immediate effect of the introduction of intelligence tests in the United States Army in 1917 was the discharge of about eight thousand men on account of mental defect, the transference of about ten thousand to labour battalions and the recommendation that a further ten thousand required special training which would allow for their low ability. Since the War of 1914–18, the measurement of intelligent behaviour has made notable advances both in theory and practice (although, judging by conditions in contemporary society, a parallel progress is far from evident in the trait to be measured), and it can confidently be anticipated that the outcome of a major testing programme carried out now would involve results of great consequence.

* Twenty-Second Report of the Select Committee on National Expenditure. (London: H.M. Stationery Office, 1941.)

In spite of the increase in mechanization, it still remains true that the human element in warfare is, in the long run, more important than technical devices. A necessary condition of the efficiency of any mechanism, organism or organization is that every component should be optimally situated in relation to the whole. To each constituent part should be assigned its most appropriate function. For society to attain that stage of efficiency so essential in total war, full use should be made, so far as is humanly possible, of all the native ability and skill, all the training and qualities of personality that are available. In so far as we fall short of this objective, to that extent are we inefficient. It is, of course, assumed that the supply of talent, innate and acquired, should be related to the military and civilian needs of the nation at war.

The review by Dr. C. S. Myers in NATURE of May 10, 1941, of the applications of psychology already achieved in the present War, indicated the many possibilities of utilizing psychological methods in the Fighting Services and industry. Several examples were quoted in which individuals had utilized such methods, but there is little sign that those in authority regard them as more than interesting experiments.

The report of the Select Committee recognizes that many mental tests in use until now have not fulfilled the selective functions for which they were presumably designed. No doubt this can be

attributed partly to the extended use of verbal rather than perceptual and performance tests. Apart from the existing evidence, which points to a verbal factor orthogonal to intelligence, the use of verbal tests puts schooling at a premium and does not effectively discriminate between the native ability of persons differing widely in educational background, as must be the case in a conscript army.

It is unfortunate that the outworn idealistic belief that abilities are mere entities seated in the mind still makes its influence felt in test construction. A more realistic approach is desirable. So far as the Services are concerned, the guiding principle should be the need for selecting persons capable of performing the tasks required by the more specialized units of the armed Forces. The ability should be defined by the test, not the test by the ability; and the design of the test should, in general, be determined by the activities called into play in the actual performance of the work for which selection is needed.

The elimination of feeble-minded and backward soldiers before money and training have been wasted upon them ought to present no difficulty; tests are available, specially built to deal with these problems. But the careful segregation or placing of neurotic types needs the employment of a new kind of criterion. The Committee's recommendation that the Ministry of Labour and National Service should, in future, not be responsible for posting men to any particular corps but only to the army as a whole, will it is hoped, be put into effect with as little delay as possible.

The suggestion that the testing should rest entirely in the hands of Service personnel is open to criticism. It needs to be stressed that so far as possible the testing in all its stages should be under the control and supervision of qualified psychologists, with a status similar to that of the existing medical boards. Otherwise, the scheme is likely to defeat its own ends. Serious defects in the conditions of administration of the tests can invalidate the results, as may happen if the work is entrusted to officers who have only been given some slight instruction in the preliminaries of testing. The following instances taken from a mechanized unit are instructive. An officer charged with the administration of the tests was accustomed to inform the candidates, after imparting other misleading information, that "they all had an equal chance of doing equally well on the tests", which is the very opposite of the truth. The period immediately prior to the testing was frequently spent 'on the square' and the men were consequently in various stages of fatigue. No account seems to have been taken of poor health at the time of the test. Furthermore, a well-intentioned sergeant apparently always did his best to assist the men in the test; he thought it was the correct thing to do. Copying also went on.

The advantages that would have followed the introduction of scientific methods of selection before or at the outbreak of war will, it seems, be largely obviated because the bulk of the men in the Forces have already received their training and, in the present circumstances of war, transfers on a large scale are considered undesirable. This is recognized by the Select Committee. However, if it is too late in one sphere, the moment is opportune to begin in another. Now is the time to sort out the thousands of youths that have joined the Air Training Corps. Here it is possible, with the aid of psychological tests, to achieve a great economy in time and expense by providing a differential training according to capacity and temperament.

The sphere in which purely psychological criteria of selection, in addition, of course, to physiological tests, could reap their greatest reward is probably that of pilot selection. Now, while there is no reason to question that the medical authorities have availed themselves of the best diagnostic techniques, there are grounds for believing that the possible contributions which psychology has to offer in this urgent field have by no means been fully explored. No effort should be too great to select, with the utmost care, the relatively small number of future pilots out of a much larger number of candidates. It is here that, added to the minimum requirements of intelligence, the qualities of temperament and character exert their most crucial effects. The problems are exceedingly complex. Nevertheless, the traits subserving mental stability, persistence, prolonged attentive power or the capacity to respond rapidly to a succession of surprise stimuli, to mention a few, should not wholly elude measurement. Those characteristics by which a day fighter pilot may be discriminated with a maximum of accuracy from the night fighter pilot and both from the bomber pilot merit all the resourcefulness and imagination in psychological measurement which are available.

The use of diagnostic criteria of ability in the selection and promotion of officers is also advocated by the Select Committee. It would be interesting to know how this would affect the existing distribution of ability among the commissioned ranks. However, given a certain level of intelligence, stress is laid in the report upon qualities of personality, and new experimental methods of assessing the relevant qualities are urgently needed. The system of promotion by seniority, wherever it is employed, is not necessarily calculated to elevate to posts of greater responsibility those men who are distinguished by superior

talents. If anything, increase in age beyond a certain point is probably inversely correlated with many of the qualities which make for success as a soldier. An officer, as a result, let us say, of bravery in the field, may be given a post in which matters relating to strategy are decided by him. But it cannot be assumed that the biological and social factors which operate to select for the quality of courage are the same as those which select for the traits which make a good strategist. Other considerations, which arise wherever appointments are to be determined by experience or by more direct estimates of capacity, also deserve weight. It may happen that a soldier with considerable military experience is entrusted with a high post mainly on this ground; but what is really relevant is the capacity to profit from experience rather than the mere fact of having had experience, and the appointment should be determined at least as much by the former as by the latter.

The scope of psychological methods in the organization of war is not confined to the application of mental tests in the Services. The allocation of new labour in industry, the human element in production, propaganda, morale and evacuation are some of the problems the solution of which would be facilitated were the aid of psychology more fully enlisted. The greatly increased number of trained psychologists which would be required could probably be provided by the Central Register, with the added advantage that the special qualifications of many able research workers in psychology would be utilized to the best advantage. It is to be hoped that the Select Committee will be able to turn its attention to these wider applications of psychology.

HIGH POLYMERS

Collected Papers of Wallace Hume Carothers on High Polymeric Substances
Edited by Prof. H. Mark and G. Stafford Whitby. (High Polymers, Vol. 1.) Pp. xix+459. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1940). 8.50 dollars; 51s. net.

Physical Chemistry of High Polymeric Systems
By Prof. H. Mark. Translated from the manuscript by K. Sinclair, revised by J. Edmund Woods. (High Polymers, Vol. 2.) Pp. x+345. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1940.) 6.50 dollars; 39s. net.

It is impossible for one author to attempt to bring within the compass of one or even a series of volumes a comprehensive and authoritative account of high polymer systems. Nothing less than a carefully chosen team of experts will suffice for the task. While the subject has come more and more into prominence in recent years this is only partly due to new knowledge of synthetic polymers, for there has accumulated over a considerable period an extensive and often unco-ordinated body of knowledge of the natural high polymers, rubber, cellulose, proteins and the like. Gradually, however, the whole subject has been cleared of indefinite opinions and conceptions, and some degree of order introduced into this branch of chemistry. This does not mean that all the fundamental problems are solved, and it is now only a question of settling matters of insignificant detail. Much has yet to be done, and a first step in the process is a clear survey of the existing state of affairs. This is the object of the editors—R. E. Burk, H. Mark and G. S. Whitby—in the volumes under review.

Appropriately enough the first volume of the series comprises the collected papers of the late W. H. Carothers. It is difficult to realize that in the short space of nine years Carothers not only contributed handsomely to the subject of polymers but also brought into being two well-known plastics of unique properties—'Nylon' and 'Duprene' (polychloroprene). In these collected papers we see the train of thought which led to the discovery of these substances. Their discovery was no idle shot in the dark or the outcome of a lucky experiment. It was the result of a most painstaking and systematic search at a time when intuition played a large part. In his first paper, Carothers clears the ground by considering in general the theory underlying the formation of condensation polymers; that is to say, it is an attempt to predict whether bifunctional molecules will react inter- or intramolecularly. On this basis an examination is made of those molecules which form polymers, but it is soon shown that the molecular weights of the products are rather low to be of interest from the plastic point of view. The matter is not left there, for it is realized that higher polymers may be formed only if the reaction is finally carried to completion in a molecular still. At this stage molecular weights of the order of 10,000 become a practical proposition, and thereby the prospect of obtaining synthetic fibres of sufficient strength immediately presents itself. Carothers carries the

argument to a logical conclusion by taking two further steps. The first is the realization that lateral interaction between macromolecules is a prerequisite for mechanical strength. The second is that such macromolecules must be orientated side by side and parallel to the fibre axis. Both are achieved, one by resorting to the polyamide system and the other by successful cold drawing of spun fibres.

The search for a variety of rubber exempt from the disadvantages of the natural material proceeded in a similar logical fashion. Here, however, the basic substances, namely vinyl acetylene and divinyl acetylene, were available and the problem was to make from them a satisfactory rubber. Innumerable compounds of hydrochloric acid with these two reactive hydrocarbons were investigated, with the result that in so far as dienes are concerned we now have a much clearer picture of the general type of diene system likely to give rise to molecules of high enough molecular weight. The relationship between rubber-like properties and chemical constitution was not revealed by these researches. Another interesting line of work, upon which there is only one paper, is the synthesis of saturated hydrocarbons of high molecular weight up to $C_{90}H_{182}$. There are many other papers full of new ideas and suggestive side-lines of which mention cannot be made. They all go to show that, had Carothers been spared, he would have made even greater strides than in this decade of intense and fruitful activity.

The second volume in the series, by Prof. Mark, really is Vol. 1 of the systematic treatment of high polymeric substances. This is shown most clearly by the fact that there is very little about polymers except towards the end of the book. It is, however, necessary in a comprehensive treatise to describe in some detail the physico-chemical methods required to deal with the reactions and structure of high polymers. Certainly such a description may be found in a variety of monographs on physical chemistry. In this volume all that is necessary for an understanding of polymers is brought together conveniently and compactly. Enough is given of modern valence theory to form a good basis for the discussion of methods used for the determination of interatomic distances. There is especially a detailed description of X-ray methods as applied to crystalline and amorphous matter. Since the peculiar properties exhibited by high polymer systems are due to a very large extent to the character of intermolecular forces, there is a section dealing with this aspect of the problem.

Molecular weights of polymers are almost invariably determined by measuring the osmotic pressure or viscosity of solutions. Unlike solutions of small molecules, polymeric solutions behave in an anomalous manner, and thus the interpretation of measurements is still a source of intense and as yet inconclusive controversy. It is here that the subject needs exact treatment. Ultracentrifugal technique is not described in detail, but enough is given to indicate the potentialities of the tool.

The mechanism of polymerization, as revealed by kinetic studies, is briefly mentioned, but again lack of space prevents any thorough treatment of the topic. Much has had to be compressed into this volume, and it is a tribute to the author that the subject is presented so clearly and pleasantly. For those not specially interested in high polymers this volume gives an unusual approach to certain parts of physical chemistry not found in the normal text-books.

It is to be hoped that, in spite of difficult times, the editors will find it possible to complete the task of which the present volumes represent a very welcome beginning.

H. W. MELVILLE.

MUSEUM EDUCATION FOR THE YOUNG

Youth in Museums

By Eleanor M. Moore. Pp. ix+115+12 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1941.) 12*s*. net.

THIS volume gives a clear picture of the very important part taken by American museums in the education of children. The author received a generous grant from the Rockefeller Foundation which enabled her to visit 103 museums in the United States for the purpose of studying the work that is being done for children. She also visited museums at Vancouver and Toronto.

The history of the development of museum education for the young is not outlined, but the author remarks that the importance of youth in museum progress is a "comparatively recent realization". It may be recalled, however, that in the United States and also in England there were, even in the 'eighties, far-seeing museum educationists who fully realized the desirability of catering for youth. In 1887 the Horsfall Museum at Manchester was encouraging children's visits and lending pictures and objects to schools, and about that time Sir Jonathan Hutchinson was holding classes for the young in his Educational Museum at Haslemere, where, a few years later he held examinations for children which included the identification of objects and portraits.

By 1900 several of the larger American museums had established sections or galleries specially adapted to the comprehension of children, and prizes were offered for essays.

Gradually it dawned upon the American public that youth is "the life-blood of museums", and, when this was fully comprehended the formation of children's museums was developed with tremendous and characteristic energy. At the present time there are at least two thousand adult museums, and children's museums "are springing up everywhere almost overnight like mushrooms", but those founded without requisite knowledge and without public backing will either quickly pass out of existence, or, like many museums in small towns in the British Isles, struggle on though "doomed to stagnation and eventual extinction".

The successful ones, established with inspiration and foresight, are controlled either by boards of education or by individual schools. A few children's museums are controlled by their own boards, and yet others are a separate but distinct part of well-known adult museums.

A children's museum may be defined as one containing objects selected, exhibited and interpreted for children in a place set aside for children. The title has been subjected to criticism—variants are "Junior Museum", "Recreation Museum" and "Little Museum". There is only one American museum styled "educational"; its principal function is "the lending of large numbers of objects to the public schools of the city [St. Louis] at the request of teachers". Some people, doubtless with dismal recollections of the gloomy and dry-as-dust museums of fifty years ago, even hold that the word "museum" is a forbidding one "for any active modern concern, especially where the stress is laid on making children feel a home-like atmosphere". The reviewer's experience, however, is that if the activities are sufficiently attractive, boys and girls of all ages do not give up their allegiance to the local museum.

The author points out that to-day most adult museums welcome the interest of children and do everything to encourage it. The following quotation conveys a vivid impression of the result of such encouragement in certain museums.

"The Tolèdo Museum of Art has been a veritable Pied Piper until on Saturdays traffic is almost held up by the vast hordes of children arriving for classes. The Art Gallery of Toronto has days when it is almost impossible to walk around the galleries for the children sketching and the various activities in the Cleveland Art Museum crowd the galleries in the same way. The University Museum in Philadelphia looks forward to the yearly visit of hundreds of small boys from a certain school who for years have stretched out on their stomachs on the floors whenever the spirit moves them to enjoy and record better the impressions of their visit in picture form. The Seattle Art Museum and the Newark Museum point out with pride the stone camels continually kept polished by children riding them, and Venus' knee, so shiny and dirty from small hands caressing it every time children pass. These do not point to the fact that children are not wanted or that they cannot be made to feel at home. Many an adult instead of being annoyed is seen to smile at their unconcern over adult intrusion."

Allusion is made to the falling off in museum attendance of high-school boys and girls. It probably results from lack of time as much as from the absorption of new interests. In some places children's clubs have been established in direct connexion with the museum, and the members make expeditions to collect not only flowers and insects but also minerals and fossils—a sound plan which, if adopted in Great Britain, might revivify some of the languishing rural museums.

The author very rightly insists that "No matter how small its beginnings the first thought in the minds of those organizing children's museums must be the setting up of standards. No matter how slowly or how fast the enterprise takes hold those same standards must be upheld to the end to insure the right to assume the name of museum."

We are assured that "from all directions come requests for more publications and of a different type from the usual technical bulletins which most museums offer the public". The demand is met in various ways: for example the Buffalo Museum of Science prints for free distribution coloured game cards, approximately 5 in. × 7 in., with the game—it concerns exhibits in the museum—on one side and an invitation to visit on the other. The Cincinnati Museum of Natural History issues a miscellaneous publication of 330 facts and questions chosen at random to direct attention to the Museum. Here are two of the questions: "Do you know that a single oyster eats 72,000,000 organisms in one day?" "Do you know that snakes walk on the end of their ribs?"

The great value of practical demonstrations is stressed, for such are always popular. "An individual who can actually show how to spin or weave, throw clay on a potter's wheel, paint a picture, stuff a bird, or make a plaster cast always draws a crowd—the act of doing is indeed dramatic."

This very interesting outline of museum doings for youth concludes with the anticipation that the young people's museum of the future will be "A museum whose interests will be entirely interwoven with every facility and every concern of the community, but one whose identity and influence will remain distinct".

BIOCHEMISTRY TO-DAY

An Introduction to Biochemistry
By Dr. William Robert Fearon. Second edition. Pp. xii+475. (London: William Heinemann (Medical Books) Ltd., 1940.) 17*s*. 6*d*. net.

THE new edition of Dr. Fearon's book is very welcome, for, since the first edition in 1934, much that is of profound significance in biochemistry has taken place, and the new edition shows every evidence of careful and up-to-date revision. Some of the chapters might almost be described as miniature monographs, so admirably does the author summarize the essential facts of his subjects. It is perhaps a little invidious to single out individual chapters for special mention, when all are of uniformly high quality, but those on enzymes, hormones and proteins are particularly informative. The book contains little that is non-essential, and the usual discussion of the elementary principles of physical and organic chemistry is fortunately omitted. On the other hand, there is a great deal in the book that one might not have expected to find in a so-called "Introduction", material that up to the present has only been available in the original literature or in occasional reviews.

The book is unorthodox in many ways. For example, the second chapter discusses the "Biological Elements", and the third "Inorganic Compounds", subjects that are usually and quite improperly ignored. The justification for beginning with the inorganic constituents of living matter—the "shovelful of clay"—is doubtless contained in the apt quotation from George Russell which heads Chapter 2. In later chapters, the substances with which the dry bones are clothed—the carbohydrates, proteins, lipides, and other essential constituents of the body—are discussed, together with their functions.

The quotations with which the book is seasoned form another unorthodox feature. These range from Swinburne to Chesterton, from Shaw to Tobit, the last being a particularly apposite reference. The biochemists of Dublin seem to share in the literary atmosphere of that city!

The chapter on hormones is also unconventional, first, by reason of the fact that the old name 'autocoids' has been resurrected and, secondly, because a wider range of factors than usual comes in for consideration by reason of the extended definition. Though Dr. Fearon has perhaps not quite played the game in adopting this artifice, one is glad he has done so, for the result is one of the best chapters in the book.

Unfortunately, the book is not entirely free from errors, mostly small and unimportant, though a few are of more moment. Thus the formula given for α-carotene on p. 202 is erroneous; as to a less extent is that of *iso*alloxazine on p. 206; the statement on p. 246 that vitamin D is found in the leafy part of most plants is clearly wrong, and is in fact corrected on the next page but one; and surely the identity of the vitamin D of fish liver oils with that produced by irradiation of 7-dehydrocholesterol, as established by the brilliant work of Brockmann and his colleagues, is of sufficient importance to deserve mention. A major error, or series of errors, occurs in the list of references on p. 265, where "J. Nutrition" should read "Nutrition Abstracts and Reviews" in all three instances. Another unfortunate but understandable mistake is the inclusion on p. 136 of Kögl and Erxleben's claim to have found *d*-glutamic acid in tumour tissue protein. It is to be hoped that this statement, recently proved wrong by several groups of workers, will be deleted in the next edition. Slips such as these can readily be excused when one considers the wide field that the author has covered, and the heroic struggle he must have had to bring each subject up to date.

All chemists, biologists and clinical workers will profit by a study of this book, and those whose work lies in the biochemical field will find much that is stimulating. Here we are enabled to obtain a comprehensive picture of the rapid expansion that has occurred within recent years, and those with imagination will see hints of the problems that remain to be investigated. What, for example, happens to the energy produced in the brain, "silent and motionless", by the consumption of 0·14 ml. of oxygen per gram of tissue per minute? Does the theory of energy-levels recently advanced by Szent-Györgyi supply the answer? Why does the *in vivo* oxidation of fatty acids occur at the α-carbon atom, when every organic chemist knows that the β-carbon atom is the more reactive? Is the recent observation of Kharasch that the β-carbon atom is more reactive than the α-atom in presence of peroxide or light relevant to these facts? What, if any, is the significance of the occurrence of β-alanine in pantothenic acid on one hand, and in carnosine and anserine on the other? These and like questions that spring to mind will doubtless be answered in due course. In the meantime, we are probably on the eve of further striking developments, and we must hope that the new knowledge thus gained will find its place in the next edition of Dr. Fearon's admirable volume.

F. A. ROBINSON.

The Boy Electrician

Practical Plans for Electrical Apparatus for Work and Play, with an Explanation of the Principles of Everyday Electricity. By Alfred P. Morgan. Fifth edition, revised by J. W. Sims. Pp. 328+11 plates. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1941.) 6*s*. net.

IN some quarters the die-hard tradition still lives fully up to its name and in that austere domain this volume would, no doubt, be classed and discussed as just "another of those popular books for the scientifically immature and curious". Such a label, however, would betray nothing but a complete lack of understanding of the times and of sympathy with the aspirations of adolescence. The present book is, in its way, as important to those to whom it is addressed as is many an advanced work to the established scientific or technological worker—maybe even more so in its possible influence in the formative years of youth; because of this we are glad to see the new edition.

The scope of the work is wide and, in parts, a little beyond the capabilities of the average boy experimenter who, for example, will have to advance quite a considerable way with serious studies before he understands the chapters on transmission and on A.C. circuits. No harm is done, however, by introducing these subjects, for they are subordinated to the main issue.

More particularly, the book covers magnets and magnetism, static electricity and machines, cells and batteries, electromagnetism, measuring instruments, telegraphs and telephones, induction coils, electric transmission, transformers, A.C. generators and motors, radio, electric railways, lighting, A.C. circuits, and gas-discharge tubes. The experiments and apparatus devised are such as any boy can carry out and make for himself.

The book is one of a series planned for boys with a craving for investigation, and it serves its purpose well.

S. A. S.

An Outline of Metallurgical Practice

By Prof. Carle R. Hayward. Second edition. Pp. xi+690. (London: Chapman and Hall, Ltd., 1941.) 38*s*. net.

THIS work is intended to serve as a reference book for engineers and also to assist students who are approaching the study of metals without previous practical experience. The first object is excellently fulfilled, it being understood that the term metallurgy is used in a restricted sense, to cover only processes of extraction and refining, and that it is almost entirely confined to American practice, although statistical tables of world production are included. Some previous knowledge is required of the reader, as many of the terms are not defined, and the 400 illustrations are not all self-explanatory. Thus there are several references to the Cottrell treater for dusts, but the fact that this is an electrostatic device is not mentioned. The most valuable feature is the description, under each metal in succession, of typical plants and processes, with drawings and photographs. Unlike many text-books covering similar ground, some of which have passed through many editions, the book is not burdened with accounts of obsolete processes.

Here and there, as in the section on magnesium, the lack of reference to European practice involves the omission of processes which are being used successfully, but on the whole the information is full and recent. In dealing with alloys and some smelting processes equilibrium diagrams and photomicrographs are given, without reference to them in the text, but their inclusion is stated to be deliberate, and to be intended for students who have already followed a course in metallography. As no part of the discussion is based on them, the technical reader without such knowledge is not confused.

Each chapter concludes with a table of the principal properties of the pure metal, and where these have been checked they have been found accurate, although it is not enough at the present day to record hardness only on the Mohs scale. The book is well produced, but the large type employed makes it rather bulky.

C. H. D.

The Fauna of British India

Including the Remainder of the Oriental Region. (Published under the patronage of the Secretary of State for India in Council.) Edited by Lt.-Col. R. B. S. Sewell. Diptera. Vol. 6: Family Calliphoridæ. By R. Senior White, Daphne Aubertin and Dr. John Smart. Pp. xiii+288. (London: Taylor and Francis, Ltd., 1940.) 18*s*.

THIS latest addition to "The Fauna of British India" series deals with a group of considerable economic importance, since it comprises those creatures known as 'blow-flies'. At the same time it is concerned with a group greatly needing thorough study. The authors regard the Calliphoridæ as forming a family separate from the Tachinidæ, to which they are closely related. They deal very fully with the external morphology of its members and include in the account a useful illustrated description of the male genitalia, which are of pre-eminent importance for the separation of the different species. While the primary object of their work is taxonomic, the authors give indications regarding the biology of the various species wherever anything at all is known on the subject. Notwithstanding the unpleasant habits of most of their members, the Calliphoridæ are a group of very definite biological interest owing to the diversity of larval and adult habits and the great range of coloration displayed by the flies.

We can recommend this volume as an admirable introduction to the study of the Calliphorids not only of India but of other tropical lands also. The fact that it only deals with what must be a very small proportion of the fauna of these insects will, it is hoped, induce resident Indian entomologists to collect and observe them with more interest than has been shown in the past.

A. D. I.

SCIENCE AND GOVERNMENT

THE future of the relations between science and government formed the basis of several contributions at the Conference on Science and World Order organized by the Division for the Social and International Relations of Science of the British Association and held in London during September 26–28.

Sir Richard Gregory, president of the British Association, in opening the session, pointed out that men of science can no longer remain indifferent to the uses to which the powers created by their researches are put. They have the right and the responsibility to ensure that the fruits of their discoveries are not left entirely at the disposal of agencies which do not understand their nature or which misuse their promise.

Dr. J. Negrin, formerly professor of physiology in the University of Madrid, and lately head of the Spanish Republican Government, maintained that recovery, reconstruction and the laying of foundations for a lasting peace will depend fundamentally on a successful union between statesmanship and science. No less on this union depends the attainment of the immediate objective of victory in the present conflict, a victory without which our plans will be in vain. Between the statesman and science a dual relation is possible: a passive one, wherein the statesman incorporates learning, assimilates the scientific method, and becomes imbued with the scientific spirit; and an active one wherein he makes use of the teaching and progress of science.

The relation between science and government in Great Britain was discussed by Viscount Samuel. A year ago our resources of scientific knowledge and ability were still being very insufficiently used. Of late there has been a marked advance as seen in Lord Hankey's answer to a question in the House of Lords, in which he gave a full account of the numerous research bodies and advisory committees which serve as a link between scientific men and Government departments (see NATURE, April 12, p. 432).

According to Prof. A. V. Hill, Foulerton professor of the Royal Society, there are Government establishments in which the spirit is a hundred per cent right; there are others in which it is miserably wrong. In the research establishments of the Ministry of Supply, the Scientific Advisory Council and its numerous committees, chiefly composed of independent men of science (including engineers), exert a considerable and beneficial influence. The Admiralty, on the other hand, with its traditional devotion to secrecy, has always resisted any suggestion that an advisory council containing independent men of science should be set up to take an interest in its research. In the Air Ministry and now in the Ministry of Aircraft Production the conditions are intermediate.

It is not necessary—indeed it would be absurd—to ask that an organization of the magnitude of the Scientific Advisory Council of the Ministry of Supply should be set up in every department; but a panel of two or three independent advisers at least is necessary if opportunities are not to be missed. It is essential, if the scientific minds of workers in Government employment are to be saved from sterility, and their souls perhaps from damnation, that there should be as little distinction as possible between them and those in the universities, in industry, and in other independent institutions. In Great Britain we do not believe in bureaucracy. Our national genius has evolved a system by which the activities of officials are continually subject to the advice and help and criticism of public-spirited citizens.

Prof. J. B. S. Haldane, professor of biometry in University College, London, compared conditions in Great Britain with those of the U.S.S.R. He pointed out that in Great Britain the distinction between the pure or academic scientist and his industrial colleague is fairly sharp. In the Soviet Union the gap is bridged in several ways. The same man or woman may work in an industrial laboratory and in one devoted to 'pure' research or teaching. Laboratories engaged in 'pure' research are occasionally assigned certain technical problems.

To prevent the formation of a bureaucracy, the Soviet system is resorted to. The workers in laboratories, including technicians, frequently meet to discuss its problems. In this way centralization from above is balanced by initiative from below.

As Prof. Hill pointed out, there are several ways of ensuring that the initiative and keenness of Government-employed men of science do not become blunted. One may encourage junior and senior workers alike to interchange freely with other departments, with industrial laboratories, or with universities; one may provide facilities for visiting workers, for coloquia and discussion meetings, and for attendance at meetings of learned societies; one may adopt a system analogous to that of the reserve of officers and other ranks by which the Fighting Services prepare for times of emergency. Many of the ablest workers elsewhere would rightly value a period of service in Government laboratories. The plan for a reserve of officers and for frequent and regular interchange between different kinds of institutions need not be limited

to science; it should be open to the Government service as a whole.

Mr. D. P. Riley, of the University of Oxford, speaking on the world planning of scientific research, put forward an eloquent plea for a greater share for the younger men of science in the counsels of scientific planning—a plea which it is hoped will receive sympathetic consideration. He suggested that as an essential supplement to present official plans, we put into direct contact with each other rank-and-file men of science in similar fields of science but working in different countries.

The past shortcomings of British colonial policy were discussed by Lord Hailey, who made several important suggestions for future consideration. It is advisable that the facilities afforded by all great imperial institutions of research should be utilized to the fullest extent and that the energies of colonial research workers should be strictly limited to problems requiring local inquiry. As Dr. Wilder Penfield, president of the Royal College of Physicians and Surgeons of Canada pointed out, if the universities of the United States and the Dominions were kept fully informed on all problems, they might well take up the torch of practical research.

The application of scientific organization to a department of State can be divided into five interlinked stages, according to Prof. J. D. Bernal, professor of physics in Birkbeck College. These are: (*a*) Information, where modern investigation, sampling and statistical methods are used to find the nature and extent of the needs to be satisfied: from this, by analysis, problems can be formulated. (*b*) Research, where the best answers to these problems can be arrived at. This involves a definite programme of work of every grade ranging from fundamental to *ad hoc* research, and good co-ordination between the different branches. (*c*) Development, where the solutions found are worked up into a state in which they can be used in practice. (*d*) Execution, or the putting of the plan into operation. (*e*) Control or the checking of the results by new statistical methods. This is a function of a control organization working in close conjunction with the information service.

The need for closer collaboration between Government design departments and people with production experience was emphasized by Dr. J. E. D. Swann, of the Association of Scientific Workers. Technical men on production or engaged on the development of Government designs frequently comment on the unsuitability of such designs for mass production. The necessity for changes is most appreciated by the younger men of science. Older men may dream dreams; but the younger men see visions of the immense possibilities inherent in science, and they must use this vision to remove the encumbrance of outworn traditions, to sweep aside the hindrances of selfish individualism, and to develop new methods of collaboration and planning. But as Prof. Hill said, if science becomes tied to emotion, to propaganda, to advertisement, to particular social or economic theories, it may cease altogether to have its general appeal, and its political immunity will be lost.

That emotion and intelligence, united in a common objective, obtain astounding results in thought, in action and in conduct was rightly claimed by Mrs. S. Neville-Rolfe, of the British Social Hygiene Council, who also pleaded for a fuller appreciation and utilization of youth in helping to muster the forces of evolution and directing them to the development of man.

There is an overwhelming need for collating, interpreting and applying the various discoveries and concepts in biology, psychology, physiology, anthropology and sociology—branches of knowledge so pitifully ignored by communities and governments. The science of social biology is scarcely recognized at present; but it is one which will need to be incorporated in whatever form the policy of world reconstruction and re-planning takes after the War. In fact, the main problems of social biology are immediate, though they may take a rather modified form during the War.

As Prof. Hill stated, the deliberate application of science in government is a new method; it has never been properly or whole-heartedly tried. If it is to have a chance of success now, it must be saved from the start from sloppy thinking, careless handling or unscrupulous use. Nevertheless, Dr. Negrin stated that in periods of transition and readjustment, such as the present, science provides the statesman with a means by which he can discriminate the noxious from the sound. It provides the touchstone to reveal the senescence of traditions and to point out those which should be removed. Science can help the statesman to remove antagonism in social life and contradictions in individual conduct and collective behaviour; also to correct professional deformations in the statesman himself, by maintaining a balance in his qualities.

It is the duty of science to share actively in the search for remedies. Viscount Samuel pointed this out and added that religion and philosophy are engaged in the same quest. Only when all three recognize that they are interdependent and move together in search of the common goal will the problems of our troubled age approach their solution.

From the above contributions alone, it is seen that the commonwealth of science is a true democracy, and must, therefore, take its right place in the counsels of the world for re-planning democracy when the time comes.

SCIENCE AND THE WORLD MIND

ALTHOUGH no thorough analysis of the concept of world mind was attempted at the Conference on Science and World Order, certain aspects of human consciousness were emphasized and many interesting avenues for further investigation were opened

Mr. H. G. Wells issued the challenging statement that there is no orderly world mind as yet but only a world dementia, a gabble of unheeded and inconsecutive utterances, and that it is the business of scientific men to prepare a working conception of organized will and knowledge upon which mankind can go.

For man as a social being, the essential thing is that he stands at the growing point of a vast evolutionary process the characteristics of which we can see pretty well, according to Dr. J. Needham of the University of Cambridge. The march of living organization, the progress of the world mind, will not stand still where it is to-day. For us, at the middle point of time, the first duty is to appraise the social forces at work around us, to see in what direction they are leading: Which of them make for higher social organization, greater human unity, community and solidarity? This is the point from which we should approach traditional systems of morality.

Science is man's consciousness, his collective property of knowledge about the world in which he lives, according to Prof. Max Born, of the University of Edinburgh. For practical purposes we all agree about the direction which we wish it to take: peaceful co-operation, a maximum of freedom for the individual combined with the optimum of organized efficiency in production, economic and political security as formulated in the Atlantic Charter.

Mr. Wells stressed the fact that conditions of human life have changed so fundamentally during the last forty years that *Homo sapiens* cannot go on living as he has been doing during the past few score thousands of years. If he fails to adapt himself to the new conditions he will degenerate or perish altogether.

Aviation, radio and other means of communication have abolished distance. A stupendous increase in the power of realizing and utilizing material energy has reduced the need for unskilled labour and has led to technological unemployment.

States and communities to-day are biologically different organisms from what they were a few hundred years ago. The average age and literacy are greater; new factors—advertising and propaganda, mass production and selling—have crept in. If there is to be peace on earth henceforth, there must be a federal control of the air and of the material of international transport; of the conservation of world resources, and a declaration of human rights that will ensure for everyone a fair participation in the world's resources and a responsible ownership in our planet.

Immediate steps should be taken towards the development of a world mind: a world language with suitable spelling and phonetics and words that do not change their meaning according to circumstances and are not easily misunderstood. Finally a world-wide memory—a world encyclopædia—or better a world institute of thought and knowledge.

On the question of a world language, Mr. Wells, while highly critical of English as it now stands, considers that some slightly modified form of Basic English, with simplified spelling, might well form the basis for an international language. Prof. L. Hogben, who stated that four hundred international universal languages have been put forward since the seventeenth century, considers that Basic English possesses many of the necessary qualifications for an international language; but he is doubtful about using any of the current languages as a basis because of the prejudices associated with them.

In the matter of spelling Mr. Wells quoted Mr. G. B. Shaw as saying that about forty-one characters are needed to cover world needs.

The institute of thought and knowledge, the world-wide memory organization for the world mind, must have ready access to all the world's learning and thinking. It would include all the museums, galleries, libraries, atlases, surveys and muniment rooms in the world. Much has been done in the matter of documentation to bring together materials from a great number of countries, and the method of microphotography developed by Dr. Kenneth Mees and Mr. Watson Davis of Science Service, Washington, enables the contents of a whole library to be condensed in a small box. In addition we need for the work-room of the world mind general and particular digests, prepared by hundreds of thousands of workers continually bringing up to date and re-planning the general and particular summaries.

Mr. Wells sees in the British Association, and particularly in the Division for the Social and International Relations of Science, and in kindred associations throughout the world, the making of a great international organism for pooling the scatterbrain world into a sane effective mentality.

Through the British Association the specialist can teach and learn and yet remain human.

A proper development of the world mind can only be achieved by a correct education of the young and the re-education of the adult mind to appreciate the full significance of the developments of science. In addition, as Prof. Born pointed out, if science is to be taught in a way appropriate to its place in the world order there must exist a clear idea of the order. This is a question of economics and politics guided by principles of philosophy and religion. The two extreme and opposing theories of dialectical materialism and individualistic idealism need not be irreconcilable any more than the two theories of light, the corpuscular and wave theories, to which Bohr's principle has supplied a solution, namely that waves and particles are limiting cases suitable for the description of particular aspects of the phenomena, two different languages telling the same tale, not contradictory but complementary. We cannot eliminate from human affairs either the collective or the individualistic aspects any more than we can deal with radiation without using notions both of particles and waves. We have to reconcile the individualist with planning, which is unavoidable, and the socialist with freedom of research, which is imperative.

Dealing with the curriculum of schools, Mr. J. A. Lauwerys, of the University of London Institute of Education, stated that much of it has been inherited from a pre-scientific age and that great changes are urgently needed. We must make sure that the material presented during the lessons is relevant to the needs and the conditions of twentieth-century industrial society. A curriculum planned around natural science and social studies is required. To this end a study of the history of science and technology, such as the eight million dollar research into curriculum needs, carried out over the last ten years in the United States, is enormously valuable. Science will cease then to be a specialized study and will help to explain social organization and get people used to thinking in terms of human welfare.

Mr. J. G. Crowther, of the British Council, dealt with the education of the adult mind. In his view contemporary automatism—repetition of the same errors by nations with different forms of governments—is due to a lack of adaptation of social forms to the possibilities of technique and can only be remedied by the scientific education of the general public.

Dr. Julian Huxley, in a paper circulated under the title of "Scientific View of Education as a Social Function", likewise advocates a proper education of the parents as a prime essential. He considers this necessary in order that they should not encourage and intensify the normal infantile repressions in the child. The persistence of such repressions into adult life has several disadvantages, notably the immobilizing of a considerable amount of so-called mental energy, deadlocked between the repressing and the repressed impulses.

Thus, in one sense, the most important single task of education is not an intellectual, but a moral and emotional one, the substitution of conscious, in place of unconscious, repression in the light of tolerance and reason.

The education of the emotional aspect of personality was even more strongly emphasized by Mrs. S. Neville-Rolfe. Every educational system, she stated, has concentrated on the training of intelligence, none has yet taken cognizance of the paramount influence of the emotional condition of man or his behaviour, or attempted to apply even our present knowledge of psychology, etc. (see p. 425). A true democracy can only be created by those who are emotionally and intellectually developed, inspired with a positive purpose in life. The emotionally immature belonging to a previous generation, are not qualified to govern or to lead youth in the present world crisis. The young to-day have a deep sense of spiritual values. They can appreciate the opportunity and accept the responsibility of mastering the forces of evolution and direct them to the development of man.

The Conference scarcely touched upon the problem of how to obtain agreement and unity of action among scientific workers, a point raised by Mr. Wells in his opening remarks. All those who have followed the deliberations of groups of highly intelligent men and women, from the League of Nations Committee for International Intellectual Co-operation onwards, cannot have failed to appreciate the difficulty of obtaining a result commensurate with the great abilities of those represented on such committees.

It seems well worth while investigating how to bring about the necessary unity of feeling, and to arouse sufficient enthusiasm among people agreed intellectually upon the work to be done in order to enable them to pull together as a team. Co-opting more of the younger men in the counsels of science will undoubtedly help much towards this badly needed unity. At present some of the more progressive men of science feel keenly the neglect of their services, especially when older authorities are complaining of having too much to do, too many committees to attend, etc. Once this feeling almost of frustration is eliminated, and younger men are given their rightful place in the advancement of science, a closer unity of feeling will be established.

PHYSIOLOGY AND ECOLOGY OF CUTICLE COLOUR IN INSECTS

By Dr. Hans Kalmus

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SEVERAL papers have recently been published describing differences in the physiological properties of dark- and light-coloured cuticles of insects. Pryor[1], Fraenkel and Rudall[2], and others have shown that the darkening and hardening of the cuticle are one and the same process—a dehydration resulting from the formation of coloured compounds of protein and polyphenols. The darker the cuticle, the harder and drier it will be.

Mackenzie and Muller[3] have demonstrated that resistance to ultra-violet radiation, as measured by the survival-rate of individuals and the mutation-rate of their offspring, is greater in the wild type of *Drosophila melanogaster* than in its yellow mutants. Experiments by Buxton[4] on heat absorption indicate that dark insects become warmer than light ones when exposed to sunlight. These results suggest that the usual explanations of colour differences as protective mimicry and warning signs, which are reviewed in Cott's book, "Adaptive Coloration in Animals"[5], do not completely account for all the phenomena of insect coloration.

There appear to be five main differences in the physiological properties of dark and light insect cuticles.

(1) A dark cuticle gives better protection against high-frequency radiations. (2) A dark cuticle absorbs radiant heat more readily; it also loses slightly more heat. (3) A dark cuticle is tougher and mechanically more resistant. (4) A dark cuticle is less easy to wet. (5) A dark cuticle gives better protection from desiccation.

An individual developing a dark cuticle must necessarily have a different metabolism from a light-coloured member of the same species.

It is not suggested that these differences apply in all cases. In some insects, though certainly not in many, the hardening and darkening processes may be independent. The physico-chemical processes resulting in hardening without darkening, or in darkening without hardening, can be presumed to differ from the processes investigated by Pryor and by Fraenkel and Rudall, and they are probably worth a separate investigation. Perhaps the findings of Hurst[6] on the behaviour of the cuticle towards apolar substances may have a bearing on this problem. Again, metallic colours are usually the combined effect of dark chitin and a special surface structure. Such iridescent structures, while having most of the physiological properties of dark cuticles, will behave like light-coloured objects so far as absorption of heat is concerned. Dark coloration that is not localized in the cuticle, as in the scales of Lepidoptera and the subcuticles of hemimetabola such as stick insects and dragonfly larvæ, will also not necessarily confer the physiological properties listed above. But after full allowance is made for these exceptions, the new findings allow of the formulation of a number of new general rules, indicating new phenomena and giving the first satisfactory explanation of several facts already established. These rules may be listed and classified as follows.

A. Protection from Light

Rule 1. *Of two related forms, the one more exposed to ultra-violet radiation will be the darker.*

For example, melanic forms of insects are found at high altitudes, while those the habitat of which is shaded from light are pale in colour. The pale insects living in caves and under bark and stones die easily when exposed to sunlight. This is reported for Campodea by Handlirsch[7]. Aquatic larvæ such as those of Corethra, which live at a considerable depth and are screened by the water, are colourless, while other mosquito larvæ which live near the surface are dark.

B. Absorption from Heat

Rule 2. *If the mode of life of an insect is such that heat absorption is advantageous, it will be dark; if it is irrelevant or disadvantageous, it may be pale.*

Lord Walsingham[8] first suggested in 1885 that dark insects absorb more heat than pale ones. This has been proved by Buxton[4]. It is not correct to assume, as Schröder[9] did in his "Wärme-Schutztracht-Theorie", that a high heat absorption is always advantageous. Buxton points out that it is obviously a disadvantage to black desert forms, the dark colour of which is explained by rule 12. The small snow insects, which are often dark, must absorb as much solar heat as they can, for their size prevents them from producing or retaining much internal heat. Insects in temperate climates, like butterflies and diurnal moths, which are active during the day, have a dark cuticle, and nocturnal moths a light one.

C. Mechanical Strength

Rule 3. *Those parts of the insect body wall which are subject to great mechanical strain are usually dark.*

Examples include the dark mouth armature of

many otherwise light larvæ ; the dark colour of bee stings and many ovipositors ; and the dark head and thorax of termites and other insects which are otherwise pale. The Ipidæ which mine under the bark of living trees are dark, whereas insects and larvæ living in decaying wood are usually white. In general, boring insects show only a dark armature and head, while burrowers like the mole cricket are entirely dark. The place of insertion of the muscles in beetles is frequently dark (Tower[10]).

Rule 4. *Giant forms are usually black ; bright colours are more frequent among small insects.*

Rules 3–7 depend on the assumption that a dark cuticle is mechanically the stronger. This has not yet been directly proved. It is, however, a fact of common observation that the pale cuticle of the newly emerged imago is more easily deformed than the hard, darkened cuticle of the older insect.

Rule 5. *Hemimetabolic (heterometabolic) insects, before their last hatching, are rarely black.*

The cockroach is an example. A hard cuticle is difficult to moult, hence the exuviæ of hemimetabola are usually whitish or transparent, sometimes with dark mouth armatures and joints. It is also most likely that autotomy only occurs in hemimetabola as a hard cuticle would be difficult to break. It is interesting that very few Crustacea have a black cuticle ; Crustacea continue to moult throughout life. There may be some exceptions among terrestrial forms like land crabs and land isopods.

Rule 6. *Heterometabolic adults are found in the same habitats as their larvæ, holometabolic insects rarely so.*

The persistence of a similar cuticle confines the hemimetabolic insects to a similar environment throughout life. A good illustration is the contrast between the white termites and the dark social Hymenoptera.

Rule 7. *Holometabolic larvæ are paler than their imagines.*

This also follows from the need to moult. Exceptions are to be expected where the larvæ need more protection against desiccation than the adult forms. The larvæ of many Carabidæ and Staphylinidæ, especially if they lead a predatory life, darken deeply after hatching and after every moult.

D. Water Repulsion

Rule 8. *The parts of the insect body where wetting must be avoided are frequently dark.*

For example, the tracheal ends of many metapneustic insect larvæ, living in a liquid or semi-liquid substratum (Drosophila, Eristalis, *Gastrus equi*). Many water beetles are black. Of course, wetting can also be avoided by other means, for example, hairs or oil smears.

E. Resistance to Desiccation

Following on the demonstration by Fraenkel and Rudall[2] that dark and light cuticles differ in water content, Kalmus[11] found differences in the resistance to desiccation of body colour mutants, of Drosophila. In *D. melanogaster* the dark mutants, ebony and black, lost less water and lived longer in a dry atmosphere than the wild type, whereas the light mutant, yellow, lost more moisture and died sooner. Yellow mutants of *D. simulans*, *D. pseudo-obscura* and *D. subobscura* were less resistant than their wild-type allelomorphs. A dark cuticle therefore appears to be a better protection against desiccation than a pale one. The fact that the proportion of water lost from the tracheæ and the body surface is still a matter of controversy does not greatly affect this deduction. Some water is certainly lost through the body wall, and the cuticular layers of the tracheæ are the same colour as the body. The implications of this deduction are of a highly complex but very interesting character.

In my opinion too much stress has been laid on macro-climatic data and on isolated determinations of temperature and humidity in considering the water needs of animals. Measurements of the micro-climate of an insect's environment, and even more direct investigation of its water supply and losses, will certainly lead to a better understanding of the adaptations and protective mechanisms of different species. Almost every insect gradually dries throughout its life, and in natural conditions very many insects die from desiccation before other causes intervene. Hence perhaps the statement of antique authors "Nihil inest". We may deduce from this that the longer the life period of an insect, the greater its need for protection from desiccation, leading to the following suggested rule.

Rule 9. *Long-lived insects are darker than their short-lived relatives.*

Extremely short-lived insects, such as some mayflies, are pale.

Rule 10. *Hibernating and æstivating insects are dark.*

This is not limited to imagines. The eggs of many Phasmodea which are dropped haphazard in the open and take a considerable time to hatch are dark and hard. The eggs of Tipulidæ laid in a similar manner are also dark, whereas the eggs of other Diptera which are deposited on a moist substratum are pale and soft. The triungulid larva of Meloe which hatches in spring is pale, while the triungulid larva of *Sitaris moralis* which hatches in autumn, and hibernates, is black.

Rule 11. *Most non-black insects are found in the tropics. Their related forms become darker as one approaches the poles.*

According to Van't Hoff, a fall in temperature

of 10° C. doubles or trebles the life period; but evaporation is decreased by only about 40 per cent. Hence tropical forms need less protection from evaporation than forms living in cooler regions. Examples can be found in many insect groups. Sturtevant[12] has described this colour gradient in the Drosophilidæ of the New World. The Drosophilidæ of Japan, judging from the description and figures of Kikkawa and Peng[13] show the same correlation between colour and latitude. Alpatov[14] has found that the honey-bees of European Russia are larger and darker in the north than in the south. There is a gradient between the two forms, except in the Caucasus, where dark bees are found.

Rule 12. *Insects exposed to drought are dark.*

Some species of desert insects are conspicuously black, though most are the colour of the sand (Buxton[15]). It therefore seems that increased protection from drought can to some extent counterbalance the disadvantages of absorbing more heat (rule 2), and of being more conspicuous. The dark cuticle of many scorpions living in dry habitats may be explained on similar lines, although they are not insects. Where drought occurs without extreme heat, as on salt soil, larger proportions of the insects are black. Many insects flying in the hot sunshine, for example, metallic insects like dragonflies and beetles, combine a dark undercuticle, which will protect them from drying, with a reflecting superstructure that will probably protect them from over-heating.

Rule 13. *Insects which ingest abundant liquid food are frequently pale.*

This is particularly true of parasites, such as most aphids, bugs and lice. Fleas are an exception. They not only migrate, but are exposed to greater mechanical danger by their mode of activity.

Rule 14. *Insects with a wide range of activities are darker than their relatives living in permanently moist conditions.*

Wide-ranging insects and predators are frequently darker than sedentary and phytophagous forms. Island insects and forms living in small communities in widely scattered biotopes, such as small puddles, where conditions may frequently become unfavourable, may be expected to be dark; for their survival depends on their ability to resist desiccation until they again find a favourable environment.

There must, of course, be metabolic differences between pale and melanic individuals of the same species, but our knowledge of them is very meagre. Graubard[16] was unable to demonstrate any differences in the tyrosinase content of the imagines of various body-colour mutants of Drosophila, though he was partially successful in showing differences in the larvæ. The mouth armature of Drosophila larvæ in mutants of lighter body colour are usually lighter than those of wild type larvæ (Brehme[17]). The industrial melanism of insects affords an interesting field of study. One explanation often put forward, mentioned in Wigglesworth's "Insect Physiology"[18], is that the melanism is a mechanism for fixing and neutralizing the toxic organic substances produced by industrial operations. But there are many alternative hypotheses. Thus Ford[19] believes that conspicuousness is not a great disadvantage in industrial districts, where there are few predators, thus allowing the black varieties, which he and other investigators describe as "hardier", to establish themselves in competition with the less noticeable but more delicate cryptic forms. A third hypothesis is that the contaminated food of the insects in industrial districts induces gene mutations producing melanism. A great deal of work is obviously needed before these questions can be decided.

Some cases are known in which the nature of the larval environment of the individual affects the body-colour of the imago. Thus lepidopteran larvæ subjected to increase of humidity or decrease of temperature usually produce darker imagines. This has little bearing on our problem, as in this order of insects coloration is due to pigment in the scales rather than in the body-wall proper. In the beetle *Leptinotarsa decemlineata*, individuals in which the white stripes were enlarged were produced from larvæ reared in moist air (Tower[20]). This fits in with the rules enunciated above. But other species of beetles and other insects react in the opposite way to changes in humidity. These reactions of the individual are not necessarily relevant to the problem of the adaptation of a species to special ecological conditions. It is generally agreed that characters acquired by the individual are not inherited. The important factors are mutation and selection. The rules already given show the ways in which selection may be expected to act. Mutations producing the colour changes that form the raw material for selection are known to occur in many insect species in Nature. Sometimes the genes reponsible for the darker forms are dominant, sometimes recessive. In Drosophila, as in many other species, it has been proved that great differences in body colour may result from the mutation of a single gene. Different alleles must have become fixed in the different species. In some cases, such as *D. melanogaster*, *D. simulans* and *D. montium*, rather light forms have become established as the normal, and both the very dark forms, like ebony and black, and the extremely light forms, like yellow and tan, are aberrant mutants. On the other hand, there are many dark Drosophila species where the colour mutants are all lighter than the normal

type. Although body colour primarily depends on a very few genes, its stabilization in a species must be determined by many other genetical factors.

The fact that so many kinds of insects, probably the vast majority, are dark, might be put forward as an objection to the above rules. If dark colour is so widespread, why not treat it as the normal thing, instead of formulating rules to account for it in each particular case? But if this view is taken, it is still necessary to account for the existence and distribution of the light-coloured forms, which amounts to the same problem. Handlirsch[7] points out that most of the primitive types within the bigger and higher insect groups are dark. This fits in with the views on the functions of melanism here put forward, if it is assumed that the development of a supporting exoskeleton and the conquest of the air by these creatures is made possible only by heavy chitinization. But any specialization which leads to life in an environment where water supply is plentiful and great mechanical strength is not demanded will remove the necessity for dark coloration and allow the production of pale insects. On the other hand, the primitive orders of insects, the members of which have probably never strayed from a rather damp and sheltered environment, contain many pale forms which are only slightly resistant to desiccation, such as Campodea (Handlirsch[7]).

The rules suggested above will often appear contradictory when applied to the ecology of a given insect species. Some factors in its mode of life will call for dark coloration, others for paleness. The colour actually observed will then indicate what are the controlling factors in the ecology of the species. Take for example the colour gradient of related forms between tropical and colder regions. By rule 1, it would be expected that tropical forms, being more exposed to ultra-violet radiation, would be darker. The opposite is actually observed, showing that protection against evaporation, prescribed in rule 11, is the more important factor. In alpine insects, where increased ultra-violet is associated with decrease of temperature, the two factors operate in the same instead of in opposite directions, and dark colour increases with altitude. There is a similar conflict between the effects on the cuticle colour of increase of size. Because of the need for greater mechanical strength, large insects may be expected to be dark. On the other hand, small insects would seem to need more protection from desiccation, and hence have a darker cuticle than large forms. But the life period of small insects is generally shorter than that of their larger relatives, lessening their need for protection. So on balance it is among the small insects that the majority of non-black forms are found.

There are also numerous cases where several factors in the ecology of an insect act jointly in the direction of a dark (or pale) colour. The dark colour of alpine insects has already been mentioned. In the case of the tsetse fly, the dark colour may be put down to its relatively large size, its diurnal activity in a dry region, its wide range, scattered habitat, or its long life as an imago, all of which, according to our rules, favour pigmentation.

This interpretation of the physiology and ecology of dark chitin, based on its newly detected physical properties, is of course not intended to replace entirely all the conceptions about colour adaptation previously formulated. On the other hand, hypotheses about imitative coloration and the like cannot but gain in certainty and precision when the physical factors are also taken into full account. The groups of organisms the colour of which is not explicable by the above-mentioned consequences of the darkening-hardening process provide the most suitable material for the study of mimicry. Examples of this are the subcuticular colour patterns of aquatic larvæ or nymphs, for example of dragonflies; the wing patterns of Lepidoptera; the body coloration of hemimetabola. Physical and cryptic advantages might also conflict, as in the case of industrial melanism, if Ford's hypothesis is correct, and among the desert populations described by Buxton, consisting of imitative sand-coloured as well as drought-protected dark individuals.

It is hoped that the new rules and considerations suggested in this article will not only provide the entomologist with a new point of view in his endeavours to bring order into his subject, but that they will also be of more general interest. Insect coloration has always been a sort of testing-ground for the theory of evolution; and insects, after all, comprise the majority of all animal species.

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OBITUARIES

Mr. William Macnab, C.B.E.

BY the death of Mr. William Macnab, on September 2, at the ripe age of eighty-four, we have to record the loss of one who not only made original contributions to our knowledge of explosives, both as to their properties and manufacture, but who in addition must be considered as a pioneer in the recognition of the importance of chemical engineering in Great Britain.

Coming from Greenock, his father being a shipbuilder there, he took up the subject of sugar chemistry, after a training at the University of Glasgow, where he made a life-long friendship with Ramsay. Fond of travelling, he spent some time in Germany in connexion with sugar and later in Canada and the United States; in Siberia also he passed an adventurous two years engaged in prospecting. He could converse readily in French, German and Russian.

About the age of thirty Macnab took up a consulting practice in partnership with C. Napier Hake and carried this on after his partner had left for Australia to become Inspector of Explosives for Victoria. It was at this period and in collaboration with Napier Hake that he undertook the translation and collation of Berthelot's papers on explosives, publishing in 1892 "Explosives and their Power", which is a handbook constantly referred to by all explosives chemists. This book describes the application of thermochemistry to explosives, gives Berthelot's calorimetric data for explosive reactions over a wide field and deals with many explosive phenomena.

At this time Macnab began his original contributions to the study of explosives, and with E. Ristori published researches on partially gelatinized and on fully gelatinized propellants (*Proc. Roy. Soc.*, 56, 8; 1894). A bomb of the Berthelot type was used; heat values and volumes of gases given off with their composition were measured, together with the metamorphosis undergone by gelatinized mixtures of nitroglycerine with various nitrocelluloses when exploded in the bomb. This work had importance as well as accuracy, as was shown by the agreement of products with original composition of explosive. Pressures were measured in another bomb and these agreed with the values found by Sir A. Noble. Later (*Proc. Roy. Soc.*, 66, 221; 1900) the same authors described attempts to determine the temperature of explosion (apart from its calculation from heat values and specific heats) by a method depending on the use of thermocouples of gradually decreasing diameter, the deflexion of a galvanometer mirror being photographically recorded. Although absolute values for temperature were not obtained, the results placed different explosive mixtures in a comparative sequence. This subject was continued in collaboration with A. E. Leighton (*J. Soc. Chem. Ind.*, 23, 298; 1904) when the heat values were compared with the galvanometer throws, the order of the powders being broadly the same in both cases.

Always interested in chemical manufacture, Macnab played an important part during the War of 1914–18, when he became a technical adviser on Lord Moulton's staff, where full use was made of his experience in the manufacture, as well as knowledge of the properties, of explosives. Working in close conjunction with Kenneth B. Quinan he was intimately associated with the design of factories for high explosives and propellants, as well as with their administration when erected. Impressed by Quinan's method of holding monthly meetings of his factory staffs at which costs and efficiencies were minutely discussed, resulting in notable improvements in technique, Macnab undertook after the War the compilation of an important series entitled "Technical Records of Explosives Supply, 1915–1918" (H.M. Stationery Office), dealing with intermediates and finished explosives. These are valuable studies in which the chemical engineering aspect is emphasized, and serve as text-books for any school in that subject, for they include not only the theory of the processes, but also sketches of designs of plants, instructions for running them, calculations of heat-transfer and loss, and choice of materials of construction. They are so framed as to assist a student engaged in general chemical engineering problems, not necessarily those dealing with explosives.

This methodical approach appealed to Macnab, who lectured on the subject at University College, London, and led to his support in starting the Department of Chemical Engineering there. This movement was strongly urged by Quinan also who had felt the grievous lack of chemical engineers during the War of 1914–18. Some chemical achievements during this time were described by Macnab in his Hurter Memorial Lecture in 1922. For the same reason he acted as one of the founders of the Institution of Chemical Engineers, becoming its president in 1934, the William Macnab Medal of that Institution commemorating his name. Much of the success of the Seventh International Congress of Applied Chemistry in 1909 was due to him. For his work in the War he was made a C.B.E. in 1920.

Of striking appearance, suggesting robust health, with rosy cheeks and pointed beard, always dressed with perfect neatness, he will be remembered for his geniality and unselfish kindliness; and his friends will remember the hospitality of his charming wife and himself at his house on the river, where it was his custom to entertain them, take them out in one of his craft, for he was a master sailor, and to some of them show his experiments in calorimetry with a large bomb that needed his athletic frame to manhandle. In his London house also, his skill at the piano and liking for good music will be remembered by many.

ROBERT ROBERTSON.

NEWS AND VIEWS

Foundation of a Nutrition Society

Workers engaged in research on nutrition in Great Britain have been feeling the need for a scientific society devoted specifically to their subject. In the past no organization has existed to enable investigators in the many and varied branches of the science—clinical, physiological, agricultural and sociological—to find a common meeting-ground for discussion and the exchange of views. Representative workers in all these fields accordingly decided recently to form a Nutrition Society. The new venture owes its conception to a circular letter signed by the following heads of some of the better-known centres for research on nutrition in Great Britain: Sir Joseph Barcroft, chairman, Food Investigation Board; Dr. Harriette Chick, head of the Division of Nutrition, Lister Institute; Prof. J. C. Drummond, scientific adviser to the Ministry of Food, and professor of biochemistry in University College, London; Dr. John Hammond, superintendent of the Animal Research Station, Cambridge; Dr. Leslie J. Harris, director of the Nutritional Laboratory, Cambridge; Sir Frederick Gowland Hopkins, professor of biochemistry in the University of Cambridge; Prof. H. D. Kay, director of the National Institute for Research in Dairying, Reading; Sir Charles J. Martin, formerly director of the Lister Institute of Preventive Medicine; Sir Edward Mellanby, secretary of the Medical Research Council; Sir John Orr, director of the Rowett Research Institute, Aberdeen; Prof. R. A. Peters, professor of biochemistry in the University of Oxford. Later a meeting was held at the Royal Institution attended by representatives from the various institutes, and the following provisional committee was formed: Sir John Orr (*chairman*); Dr. John Hammond (*vice-chairman*); Dr. Leslie Harris (*hon. secretary*); Mr. A. L. Bacharach (*hon. treasurer*); Dr. Harriette Chick, Dr. E. M. Cruickshank, Dr. H. H. Green, Prof. H. P. Himsworth, Prof. A. St. G. Huggett, Dr. Franklin Kidd, Dr. S. K. Kon, Dr. B. S. Platt and Dr. H. M. Sinclair.

It is, of course, not intended that the new Society should compete in any way with existing scientific societies; its functions would be complementary to theirs and would cover a more general and in some ways less specialized field. It is proposed that the main activity of the Society at the beginning should be to hold meetings at various research institutes, at each of which some specific topic should be discussed; several main papers would first be read and would be followed by a general discussion. Arrangements have been made to hold the first conference of this kind at Cambridge on October 18, when the theme will be "The Evaluation of Nutritional Status". Further particulars of the Society can be obtained from Dr. Leslie Harris, Dunn Nutritional Laboratory, Field Laboratories, Milton Road, Cambridge.

Food Values of Eggs and Cheese

Healthy and well-informed public criticism is good for all Governments, particularly when, as was the case in the House of Lords debate on September 30, it is constructive in nature. The debate dealt mainly with the Government food production policy, and a good case was made out for Government support to poultry keepers in their efforts to obtain maximum egg production consistent with the maximum production of crops suitable for direct use as human food. Viscount Dawson stressed the essential value of the egg as a constituent of human dietaries, not only for its use in preventive medicine, but also because of the unique part it plays with milk in maintaining the health and vitality of children and in keeping the active population well and fit in time of war. He maintained that it would be a mistake to penalize egg production in times such as these, and in this view was supported by Lord Phillimore, who hopes that further egg production will be encouraged. That the adoption of such a policy would be in the national interest is substantiated by an article in Nature of September 20, p. 335.

References were also made to the possible utilization of two protein-rich products for animal feeding. The first, a by-product in the production of acetone, has been proved to be of value as a protein concentrate in poultry-rearing mashes, and is characterized by containing not only protein in large amount, but also in addition appreciable quantities of riboflavin and lesser amounts of pantothenic acid. The second, a synthesized vegetable protein, appears to be 'fodder yeast', a product obtained by the fermentation of molasses and ammonium salts by means of *Torula edulis*. This material received the attention of the Royal Society in the War of 1914–18, and Temperton of the National Institute of Poultry Husbandry has shown that this 'fodder yeast' is a suitable substitute for fish meal in egg production rations.

A plea was also made during the debate for the encouragement of the production of ewe milk cheese. The contention that more human food would be produced by converting ewe milk into cheese than by producing mutton is undoubtedly correct; putting it into practice, however, is the difficulty, since it means setting up a new industry as well as introducing complications in the already difficult circumstances in which the arable or grassland sheep farmer is at present working. On technical considerations it is always possible to induce a change of Government policy, since the outsider may often be better informed than the technical advisers upon whose judgment the policy has been based. Criticism, based on quantitative considerations, although well-meaning, is almost always bound to fail, since the full knowledge of the position upon which the policy is based can only be known by the Government.

Dean of the Faculty of Medicine at Birmingham

DR. A. STANLEY BARNES has resigned his post as dean of the Faculty of Medicine in the University of Birmingham after ten years in office. Dr. Barnes, who was a student of Mason College, in addition to being closely associated with the local hospitals, attained an outstanding position as a consultant. About ten years ago he sacrificed his professional practice to become dean of the Faculty of Medicine, in which office he assisted in the planning and building of the City Hospitals Centre and the new Medical School of the University. He was a liberal donor to the building funds of the Medical School, and the perfection of the building and equipment reflects in many directions both his discriminating generosity and constant supervisory care. The Council of the University has recorded its grateful recognition of the valuable and devoted service which he has rendered to the University and to the cause of medical education in Birmingham generally.

Dr. Barnes is succeeded as dean by Dr. Leonard Gregory Parsons, professor of infant hygiene and diseases of children, who has been acting as deputy dean. Dr. Parsons, who was educated at King Edward's School, Aston, and the University of Birmingham, is physician to the United and Children's Hospitals, and was chairman of the Children's Hospital, an office which he resigned in January last, to become Midland Regional Hospital Officer to the Ministry of Health. During 1916–18, serving in the R.A.M.C., Dr. Parsons was officer in charge of the Medical Division 36th General Hospital, British Salonika Force, the Order of St. Sava of Serbia being conferred on him in 1917. He was vice-president of the International Congress of Pædiatrics at Stockholm in 1930 and president of the Children's Section of the Royal Society of Medicine during 1932–33.

Science and World Order

SPEAKING at a meeting convened by the Faculty of Science of Marx House on October 5, Prof. J. D. Bernal summed up the Conference on Science and World Order. The meeting, he said, tended to avoid reference to the difficulties of scientific planning at the present time. The first necessity is to win the War, and the time for planning is now. It is simple to see what we need from science, namely, an environment in which material things are at their best and have the ability to obtain a secure social life. Want and war are the two chief horrors of to-day. Science has pointed the way to remove them and will remove them if the peoples of the world co-operate with the scientific workers.

The attitude of complacency which existed in the higher scientific world is broken. Dissatisfaction is not confined to younger men of science but has reached the senior men. Dr. J. P. Lawrie, speaking at the same meeting, directed attention to the opposition displayed by high political personages when Prof. A. V. Hill organized a liaison between the men of science of Great Britain, the United States and Canada. He is of opinion that any plans made by men of science must secure the backing of the people before they can be put into effect by any Government. This means that men of science must thoroughly instruct the people, and this can best be done through the daily Press.

A Scientific Press Bureau

MR. D. S. EVANS, University Observatory, Oxford, writing with reference to the letter in NATURE of September 27 by Mr. D. L. Johnston urging the need for a scientific press bureau, states that the Association of Scientific Workers has devoted considerable attention to this problem. A scheme has been drafted by the Association whereby each of its more than fifty branches all over Great Britain can act as centres of diffusion for simple and accurate facts on scientific problems of current importance, and it is hoped that this organization will begin functioning in a few weeks. It is an amateur organization, but its possibilities are considerable, and experience will be gained which will be invaluable if, and when, a more formal body is set up. Mr. Evans states that the Association intends to develop this propaganda work for science by every means in its power, and co-operation with other organizations or individuals will be heartily welcomed.

Point is given to the proposal by headlines which appeared in a recent issue of a well-known London evening newspaper. The headlines read "Anti-Gas Serum is Being Sent To Russia"; the accompanying letter-press indicates that the reference is actually to gas-gangrene serum. The mistake is understandable, but nevertheless emphasizes the need for scientific guidance.

Dr. Arthur Gamgee (1841–1909)

DR. ARTHUR GAMGEE, F.R.S., physiologist and consulting physician, was born at Florence on October 10, 1841, the son of a veterinary surgeon and pathologist. From the outset of his career he showed a special interest in physiology, particularly physiological chemistry, as was evidenced by his inaugural thesis at Edinburgh entitled "Contributions to the Chemistry and Physiology of Fœtal Nutrition". From 1863 until 1869 he was assistant to Dr. Maclagan, professor of medicine at Edinburgh, during which time he published several papers showing his outstanding ability to deal with abstruse physiological problems. In 1873 he was appointed the first Brackenbury professor of physiology at Owens College, now the University of Manchester. During the thirteen years he was there he took an active part in the work of the medical school, of which he was dean, and wrote numerous articles on physiology and pharmacology. He was also Fullerian professor of physiology at the Royal Institution during 1882–85, when he left Manchester. Eventually he moved to Cambridge, where he devoted himself to scientific research. Finally, he decided to live abroad and settled first at Lausanne and afterwards at Montreux.

Gamgee's chief publications were "A Text-book of the Physiological Chemistry of the Animal Body, including an Account of the Chemical Changes Occurring in Disease" (1880–1893) and "Physiology of Digestion"

(1893). He also translated Hermann's "Elements of Human Physiology" (1875). In 1902 he visited the United States by invitation to inspect the physiological laboratories there, and in the same year delivered the Croonian Lecture before the Royal Society on "Certain Chemical and Physiological Properties of Hæmoglobin". He died on March 29, 1909; a portrait and bibliography will be found in the *Lancet*, 1, 1141 (1909).

Sir Richard Thorne Thorne (1841–1899)

SIR RICHARD THORNE THORNE, F.R.S., a notable hygienist of the Victorian era, was born on October 13, 1841, at Leamington, Warwickshire, the son of a banker. He received his early education at Neuwied in Prussia and at a Paris *lycée*, and his medical training at St. Bartholomew's Hospital, where he qualified in 1863. Eventually he was elected physician to the Royal Hospital for Diseases of the Chest and to the London Fever Hospital, and about this time he was employed by the Medical Department of the Local Government Board to make various reports. He first became widely known by his work on quarantine and the international relations for the prevention of the spread of disease from one country to another. From 1885 onward he attended many international sanitary congresses as a representative of the British Government, and in 1892 he succeeded Sir George Buchanan as principal medical officer of the Local Government Board. The subjects in which he was most interested were diphtheria, on the natural history and prevention of which he delivered the Milroy Lectures before the Royal College of Physicians in 1891; tuberculosis, the administrative control of which formed the subject of his Harben Lectures in 1899, and the establishment of isolation hospitals for infectious diseases. He was elected a fellow of the Royal Society in 1890 and was also an honorary member of the Royal Academy of Medicine of Rome and a foreign associate of the French Society of Hygiene. His death took place suddenly on December 18, 1899.

Recent Earthquake

A SEVERE earthquake shook Quetta and the surrounding country in Baluchistan at 8.4 a.m. local time (2.34 a.m., G.M.T.) on September 29, 1941. The shock was also felt, though less distinctly, at Sibi, Mach, and Chaman, all in Baluchistan. The shock, which lasted according to human perception for thirty-five seconds at Quetta, was accompanied by heavy rumbling, and caused considerable apprehension. Although telephone and telegraph communications were temporarily dislocated, no serious damage or casualties are reported, and railways were unaffected. This lack of damage might easily be due to the thorough building of the new city after the calamitous earthquakes of May 31 and June 2, 1935. The re-planned city was built to earthquake-proof design according to the best building codes of California as worked out by seismologists and engineers. After-shocks to the 1941 earthquake took place at 2.35 a.m., 2.54 a.m., 4.34 a.m., 5.4 a.m. and 8 p.m. (all G.M.T.) on the same day. It will be recalled that Quetta was levelled to the ground on May 31, 1935, and that an area approximately a hundred miles in diameter was devastated. A severe aftershock occurred on June 2, 1935, and altogether there were about 40,000 casualties (NATURE, June 15, 1935, p. 986 and several subsequent numbers). Severe shocks also occurred near Quetta in September and October 1937.

On September 29 at just after 5 p.m. G.M.T. an earth tremor of some severity rattled crockery and moved furniture at Bethesda, a town of some five thousand inhabitants in Wales. The shock, which lasted according to human perception for about three seconds, did not cause any serious damage or casualties. Two earlier tremors of less intensity occurred early on the morning of September 27. Earth shakes, probably due to mining subsidences and minor fault slips, occur fairly frequently in Wales. One such happened at Pwllheli on December 12, 1940 (NATURE, Dec. 21, 1940, p. 803).

Announcements

M. MAISKY, the Soviet Ambassador, has been offered and has accepted honorary membership of the Athenæum.

THE title of Sir Ernest Cassel reader in commerce in the University of London has been conferred on Dr. Vera Anstey, in respect of the post held by her in the London School of Economics.

DR. FREDERIC JOHN NATTRASS, lecturer in therapeutics and clinical teacher in medicine in King's College, Newcastle-upon-Tyne (University of Durham) has been appointed professor of medicine in the College.

THE Minister without Portfolio has appointed an Inter-Departmental Committee, under the chairmanship of Lieutenant-Colonel Sir Francis Shelmerdine, director-general of civil aviation, to make recommendations as regards the reconstruction, organization and development of civil aviation after the War.

THE fourth Hinchley Memorial Lecture of the Institution of Chemical Engineers will be delivered by Sir Richard Gregory, who will speak on "Scientific Knowledge and Action". The address will be given in the Institution of Civil Engineers on October 24 at 2.30 p.m.

The autumn meeting of the National Academy of Sciences of the United States will be held at the University of Wisconsin during October 13–15.

PROF. W. E. S. TURNER, professor of glass technology in the University of Sheffield, will deliver a lecture before the London Section of the Society of Glass Technology on "Glass as a Substitute Material" on October 15 at 4.30. The meeting will be held at the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Number of Primes and Probability Considerations

THE probability that a number chosen at random is divisible by p is $\frac{1}{p}$ and consequently that it is not so divisible is $1 - \frac{1}{p}$. On simple probability considerations, that is, provided that these probabilities are independent of one another, the chance that a number is simultaneously not divisible by a group of primes is therefore $\Pi\left(1 - \frac{1}{p}\right)$. Hence the probability that a number in the neighbourhood of N^2 is prime should be $P(N^2) = \overset{p_N}{\Pi}\left(1 - \frac{1}{p}\right)$ where p runs through the gamut of the primes from 2 to p_N the largest prime less than N. This product has the value $\frac{e^{-\gamma}}{\log p_N}$ where γ is Euler's constant.

If P is the probability of a number in a given region being prime, the number of primes in an interval Δ in this region must be on the average $\Delta . P$. Hence the number of primes in an interval Δ in the neighbourhood of N^2 should approach $\frac{\Delta}{e^{\gamma}} \frac{1}{\log p_N}$.

For large values of N, we may substitute $\log N$ for $\log p_N$, since the interval between successive primes is of the order $\log N$. Hence the number of primes in an interval Δ in the neighbourhood of N^2 should tend to $\frac{\Delta}{e^{\gamma}} \frac{1}{\log N}$. The correct answer, of course, is $\frac{\Delta}{2} \frac{1}{\log N}$, that is, about 11 per cent smaller.

It is curious that simple elementary probability considerations should give an answer so nearly right, but just failing by such a small fraction. It seems to imply that the probabilities are not strictly independent, that there is a slight tendency of factors to avoid one another; in other words, that after all the numbers in an interval divisible by $p_1, p_2, p_3 \ldots p_l$ have been eliminated, the chance that one of the remaining numbers should be divisible by another prime p_m is rather greater than $\frac{1}{p_m}$.

Perhaps a reader of NATURE can throw light on this question.

CHERWELL.

Christ Church,
Oxford.
Sept. 13.

Effect of Negative Groups on Reactivity

RECENT experimental and theoretical studies of bond strength[1] have shown that our forecast[2], according to which in the series of gas reactions $Na + XR = NaX + R$ (X = halogen, $R = R_1, R_2 \ldots$) the reactivity is inversely related to the bond strength C–X, holds true for hydrocarbon radicals R_1, $R_2 \ldots$ containing no negative groups. But the great acceleration caused by the presence of such negative groups ($X_1, X_2 \ldots$) in reactions of the type $Na + XRX_1 = NaX + RX_1$ is as yet unexplained. The presence of these groups is not usually considered to weaken the bond strength C–X. In fact, it has been suggested by Pauling that, when $X_1, X_2 \ldots$ are halogen atoms attached to the same carbon as X, the strength of all the halogen bonds is rather increased than decreased by resonance[3]. Moreover, observations on the bond energy of acetyl iodide[1] failed to reveal any such weakening of the carbon halogen bond by the negative substituent (=O), which could explain that acetyl chloride reacts much faster with sodium vapour than does C_2H_5Cl [4].

A specific effect of negative substituents on reactivity can be deduced from the fact that in the presence of a negative substituent the transition state will resonate between three structures instead of the usual two. We shall have:

1. (a) $Na \ldots XRX_1$
   (b) $Na^+X^- \ldots RX_1$
   (c) $Na^+ \ldots XR \ldots X_1^-$

the component state c being due to the presence of the negative substituent X_1.

Take the case of a number of halogen atoms $X, X_1, X_2 \ldots$ in the molecule. A sodium atom approaching a polyhalogenated alkyl will interact simultaneously with each of the halogen atoms $X, X_1, X_2 \ldots$ in the sense of the transfer of an electron: $Na + {>}C{<} - X = Na^+ \ldots {>}C{<} \ldots X^-$ and likewise for ${>}C{<} - X_1$, ${>}C{<} - X_2 \ldots$ Each of these transfers may be considered as leading to an alternative final state, producing a different alkali halide molecule with the pairs of ions ($Na^+ \ldots X^-$, $Na^+ \ldots X_1^- \ldots$) separated by various distances. All these alternative final states will resonate jointly in any transition state arising in a reaction of a sodium atom with a polyhalogenated alkyl, and will depress the activation energy.

This resonance will increase steadily with the number of halogens $X_1, X_2 \ldots$ present in the molecule and also with their specific tendency to react with the sodium atom. The first part of this statement is patently confirmed by the observed cumulative accelerating effect which halogen atoms have on the reaction rate[4]; the second part may be analysed and tested as follows. Let us first think of all X's as being the same halogen, say, chlorine. The energy of the alternative transfer of the electron to the different Cl atoms increases with the electrostatic energy of the pair $Na^+ \ldots Cl^-$, which is inversely proportional to the distance at which the halogen is situated from the Na atom at the moment of reaction, that is, in the transition state. Hence the reactivity of di-chloro compounds should increase

with the mutual proximity of the two Cl atoms; and we should find, in particular, that *cis* di-chloro ethylene reacts faster than the *trans* isomer. All this has been confirmed by experience[4]. Moreover, the accelerating effect of halogen substitution should increase in the series F, Cl, Br, I, which represents the sequence in which the tendency to react with sodium increases; which also has been confirmed over a wide range of observations[4].

In the electron transfer discussed above the attachment of the electron to the halide molecule is clearly a manifestation of the *electron affinity* of the latter particle. The accelerating influence of a negative substituent on the reactivity of a molecule is thus seen to go parallel to the substituent's contribution to the electron affinity of the latter.

The observed parallelism in the influence of negative groups on the rate of sodium reaction as compared with the rate of substitution by a negative ion[4,5] can be explained by the presence of additional resonance in the transition state, similar to that which we derived for the sodium vapour reaction. In a substitution reaction $X^- + RX_1X_2 = XRX_2 + X_1^-$ the transition state will have the *threefold* resonance:

$$2. \quad \begin{array}{ll} (a) & X^- \ldots RX_1X_2 \\ (b) & XRX_2 \ldots X_1^- \\ (c) & XRX_1 \ldots X_2^- \end{array}$$

where the component state *c* is due to the presence of the negative group X_2.

The latter type of resonance can be related to the mechanism postulated by A. Lapworth in his classical studies on the formation of the cyanhydrine anion from RCO and CN^-. In this sense we could write, for example, the accelerating effect which C = O has on the substitution of acetylhalide by halogen ions, as being due to the tendency $X^- \ldots \underset{X_2}{C} = O$. We could even extend this to represent the rapid reaction of the acetylhalides with sodium vapour in the sense

$$Na \ldots \underset{X}{C} = O.$$

M. G. Evans.

University of Leeds.

M. Polanyi.

University of Manchester.

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[3] Pauling, L., "The Nature of the Chemical Bond", p. 235 (1940).
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Structures of Thallium

THALLIUM at room temperature has a close-packed hexagonal structure, but this transforms at 230° C. into another structure which is given in the literature as face-centred cubic. This is based on the work of Sekito[1], who used specimens quenched from the melt and specimens containing other elements; his results cannot therefore be considered decisive, particularly since he does not give the purity of his materials.

We have taken photographs of Hilger thallium No. 7011 (99·995 per cent Tl) in the Debye-Scherrer camera described by Wilson[2]. At room temperature photographs of the hexagonal structure were obtained. Above 230° C. the photographs were not very satisfactory owing presumably to grain growth, as the metal is too soft to be finely filed. The lines present, however, did not fit in with the face-centred cubic structure, and measurement of a photograph taken at 262° C. with copper *K*-radiation showed that the pattern was mainly that of a body-centred cubic structure with $a = 3{\cdot}874 \pm 1$ A. Some of the hexagonal structure also was present. In the accompanying table a description of the photograph is given, and the observed and calculated positions of the lines are compared. Allowing for a systematic difference due to absorption, it will be seen that the evidence for the body-centred cubic structure is quite conclusive.

Indexes and Radiation	Intensity	$\sin^2\theta$ Obs.	$\sin^2\theta$ Calc.
110 β	medium	0·0645	0·0643
110 α	strong	0·0791	0·0789
$10\bar{1}1$ α	medium	0·0847	0·0848
$10\bar{1}2$ α	very weak	0·1427	0·1412
200 α	medium	0·1582	0·1578
211 β	medium	0·1945	0·1929
211 α	strong	0·2383	0·2366
220 α	weak	0·3174	0·3155
310 β	weak	0·3227	0·3216
310 α	medium	0·3963	0·3944
321 β	very weak	0·4533	0·4502
321 α	medium	0·5540	0·5521
$\left.\begin{array}{l}330\\411\end{array}\right\}\alpha_1$	weak	0·7095	0·7087
$\left.\begin{array}{l}330\\411\end{array}\right\}\alpha_2$	weak	0·7131	0·7122
422α_1	very weak	0·9452	0·9449
422α_2	very weak	0·9500	0·9497

The values of the lattice parameters of the hexagonal structure from our photographs are: $a = 3{\cdot}4496 \pm 2$ A., $c = 5{\cdot}5137 \pm 4$ A., $c/a = 1{\cdot}5984 \pm 1$, at 18° C.: these values are corrected for refractivity.

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Sept. 4.

[1] Sekito, S., *Z. Krist.*, **74**, 189 (1930).
[2] Wilson, A. J. C., *Proc. Phys. Soc.*, **53**, 235 (1941).

Propagation of Lightning Leader Strokes

THE interesting suggestions recently put forward by Bruce[1] with regard to the mechanism of leader strokes are largely based on data relating to glow-to-arc transition. However, laboratory experiments indicate that such transition is a cathode-dependent phenomenon, a fact specifically stated in two of the articles[2] cited by Bruce. The current at which the glow develops into an arc is a most variable quantity[3] and is governed by the shape and material of the cathode.

Most authorities[4] seem agreed that, in the glow discharge, electrons are liberated from the cathode by positive ion bombardment or by photo-electric effect, and also in the gas by collision processes or by

photo-ionization; transition to an arc takes place when the conditions *at the cathode* are such as to initiate a much more copious source of electrons, namely thermionic emission or auto-electronic emission.

The propagation of a leader stroke depends on ionization processes in the gas. There seems no reason to suppose that a sudden transition will take place in the leader channel at a value of current which relates to the glow-to-arc transition between metal electrodes, where all evidence points to the importance of cathode mechanisms. Thus I consider that the experimental data on glow-to-arc transition are not directly applicable to the leader stroke, which is a gas-dependent phenomenon.

A feature of the propagation of leader strokes is their development in fields of relatively low gradient. The leader stroke must therefore carry forward as it advances a localized intense field about its tip in order that its progress may be maintained. To create such a field an excess charge of the appropriate sign is required in the channel. I would then suggest that one of the criteria relating to the propagation of a leader stroke is that the gradient along the ionized channel should be such that the electron drift speed is sufficient to ensure the continuous creation of this excess charge as the leader advances. The manner in which this excess charge is produced is probably as follows:

(1) *The negative leader stroke.* The average electron drift speed u cm. per sec. along the leader channel is in the same direction as the average speed v of advance of the channel tip. If n is the number of ion pairs created per cm. advance of the leader stroke, the number of electrons in the channel is $\frac{n\,v}{v-u}$ per cm., while the number of positive ions is n per cm. (the positive ions may be considered as virtually stationary in comparison with the more mobile electrons). There is then an excess of electrons in the channel, namely, $\frac{n\,u}{v-u}$ per cm., which maintains the negative character of the advancing leader.

(2) *The positive leader stroke.* The direction of electron drift in the leader channel is in the reverse direction to that of advance of the leader. The number of electrons in the channel is $\frac{n\,v}{v+u}$ per cm., while the number of positive ions is n per cm., so that there is a resultant excess $\frac{n\,u}{v+u}$ positive ions per cm. of channel.

Further details relating to the amount of excess charge required in a leader channel will be published in due course.

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Sept. 2.

[1] C. E. R. Bruce, NATURE, 147, 805 (1941).
[2] Todd, F. C., and Browne, T. E., *Phys. Rev.*, **36**, 732 (1930); Fan, H. Y., *Phys. Rev.*, **55**, 769 (1939).
[3] Suits, C. G., and Hocker, J. P., *Phys. Rev.*, **53**, 670 (1938); Suits, C. G., *J. App. Phys.*, **10**, 648 (1939).
[4] Druyvesteyn, M. J., and Penning, F. M., *Rev. Mod. Phys.*, **12**, 89-90, 140-41 (1940); Loeb, L. B., "Fundamental Processes of Electrical Discharge in Gases" (Wiley and Sons, New York, 1939), p. 605 *et seq.*; Compton, K. T., *Trans. Amer. Inst. Elect. Eng.*, **46**, 868 (1927); Seeliger, R., *Phys. Z.*, **27**, 730 (1926); von Engel, A. and Steenbeck, M., "Elektrische Gasentladungen" (J. Springer, Berlin, 1934), Vol. 2, pp. 119, *et seq.*

Magnetization of Matter by Ultra-violet Radiation

I HAVE attempted to repeat the interesting experiments reported by Ehrenhaft and Banet[1] on the effect of ultra-violet radiation on "non-magnetic" and annealed pieces of iron. They stated that, with the simplest apparatus (for example, a cheap compass needle), they showed that poles were induced in various pieces of annealed iron, the poles being mainly north magnetic. The specimens were placed perpendicularly to the geomagnetic field and irradiated for periods varying from minutes to several hours. The poles, they state, were present in many specimens after several days.

My experiments were carried out under similar conditions, and, within the limits of sensitivity of the magnetometer used, they were entirely negative. This sensitivity was about 9,000 mm. at 1 metre per œrsted, and was such that a pole strength of 0·01 C.G.S. unit (or a magnetic moment of 0·05 C.G.S. unit) on the specimen tested could be detected clearly. A small compass needle was found to be less sensitive and reliable. In the various tests I used two types of ultra-violet source, direct exposures to within 10 cm. of the source and also at the focus of a quartz lens, exposure times ranging from minutes to several hours, various angles from 0° to 90° between radiation beam and specimen, and many specimens of the kind mentioned by Ehrenhaft and Banet. In no case was there a significant increase in magnetization. An occasional specimen, accidentally dropped, became magnetized by the earth's field.

It was shown that the weak poles (of order 0·01–0·1 C.G.S. unit) induced by placing a specimen in the earth's field and tapping it could be detected with certainty by the magnetometer, and often by the compass needle.

The first ultra-violet lamp used by me was an Osira, 125-watt, high-pressure type (General Electric Co.). Its glass globe had been removed, and the ultra-violet flux density in the region 3132 A. and less had been determined in previous work[2] (39 microwatts per cm.^{2} at 61 cm. horizontally from the source). The second source was a Mercra lamp, 125-watt, with ultra-violet filter bulb (British Thomson-Houston Co.).

I would like to know if anyone else has tried these experiments, and their results.

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July 16.

[1] Ehrenhaft, F., and Banet, L., NATURE, **147**, 279 (1941).
[2] Edie, E. G., and Focken, C. M., *Trans. Roy. Soc., N.Z.*, **71**, Part I (1941).

Distillation 'Constants'

WE have become interested in the relationships existing between some of the older 'distillation constants' and the more recent concept of relative volatility (α of Walker, Lewis *et al.*[1]). To find the rate of change with composition of total vapour pressure (P) of a binary mixture Rosanoff, Bacon and Schulze[2] put forward the general equation (deduced empirically)

$$\frac{dP}{dx} = \frac{1}{K}\log\,[p_1(1-x)/p_2x]. \quad . \quad . \quad . \quad . \quad (1)$$

p_1 and p_2 were the partial vapour pressures (at a particular temperature) of the components, the

molecular fractions of which in the liquid were x and $(1-x)$. The constant, K, held for all cases and was evaluated as follows: When in a particular case where Raoult's law held, that is,

$$[p_1(1-x)]/p_2x = P_1/P_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$P=p_1+p_2=P_1x+P_2(1-x)=(P_1-P_2)x+P_2\,; \quad . \quad (3)$$

then $$\frac{dP}{dx} = P_1-P_2= (1/K)\log\,[p_1(1-x)/p_2x]$$

$$= (1/K)\,\log\,P_1/P_2\,; \quad . \quad . \quad . \quad . \quad (4)$$

whence $K = (\log P_1 - \log P_2)/(P_1-P_2)$. . . (5)

P_1 and P_2 were the vapour pressures of the pure components (at the temperature in question). Rosanoff *et al.*[2] evaluated K for a number of pairs of liquids and extended their considerations to obtain liquid-vapour equilibria points from measurements of total vapour pressures, etc.

A relationship between K and α can be deduced as follows: Since by definition (Walker *et al.*[1])

$$\alpha = p_1/p_2\left[\frac{1-x}{x}\right], \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

equation (1) becomes

$$\frac{dP}{dx} = \frac{1}{K}\log\alpha\ (\text{or } \alpha = e^{\,K.dP/dx})\,; \quad . \quad . \quad . \quad (7)$$

whence

$$K = \log\alpha/\frac{dP}{dx}\,; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and for pairs of liquids which obey Raoult's law—equation (2)—and in general,

$$K = \log\alpha/(P_1-P_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

At a later date the relationship between α and other distillation constants[3] will be discussed.

Incidentally, the equation of Rosanoff *et al.* relating E_0 and x_0, the initial weight and initial molar fraction of a component in a binary mixture, with E and x, the quantities remaining in the mixture after a finite partial distillation, namely:

$$\ln\frac{E}{E_0}=\int_{x_0}^{x}\frac{e^{\,K.dP/dx}}{(e^{\,K.dP/dx}-1)\,(1-x)\,x}\,.dx \quad . \quad . \quad (10)$$

can be written in the form

$$\ln\frac{E}{E_0}=\int_{x_0}^{x}\frac{\alpha}{(\alpha-1)\,(1-x)x}\,.\,dx, \quad . \quad . \quad . \quad . \quad (11)$$

which on integration, provided α is constant, gives

$$\log\frac{E}{E_0}=\frac{\alpha}{\alpha-1}\left[\log\frac{x_0}{x}+\log\frac{1-x}{1-x_0}\right]. \quad . \quad . \quad (12)$$

A similar equation may be written for the other component[4].

Reilly and Kelly[5] have shown that the distillation constant, k, for pairs of liquids used by Virtannen and Pulkki[6], is the same as α on the condition that Raoult's law holds. It is hoped to show in a later publication that this condition is not necessary. It would therefore appear that the technique of Virtannen and Pulkki[6] can be applied to determine α for pairs of liquids which form azeotropes. It should be noted that components which form an azeotrope deviate from Raoult's law. Even if Raoult's law has to be obeyed by the components for k and α to be the same, there would still be a possibility of the above method being applied to azeotropic components. Hildebrant[7] points out, in another connexion, that, in certain cases, it does not take much deviation from Raoult's law for an azeotrope to form. However, it would appear at the moment that the only criterion necessary for the similarity of k and α is that the relative volatility of the two components should be constant (or approximately so) through the temperature range of the small partial distillation necessary to determine k. In practice, a series of small partial distillations, or a single distillation into several small separate portions of distillate, is carried out to determine k for different compositions. Walker *et al.*[1] point out that, in general, relative volatility does not vary rapidly with temperature. Consequently, as a general rule, k should approximate to α in a given partial distillation. For an infinitesimally small partial distillation, k would become identical with α.

A pair of liquids mixed in the exact azeotropic composition has a value of α equal to unity. For other compositions α varies from values greater than unity to less than unity depending on which component is present in excess of the azeotropic composition in the mixture. The determination of k can be carried out quickly (even if using the more elaborate technique of Rosanoff, Bacon, and White[8] for distillation into separate portions of distillate) and the values of k for a range of compositions rapidly ascertained. If k approximates to α then a curve relating k with a range of compositions should have an inversion point, where an azeotrope is formed, at about the co-ordinates of k equalling unity and composition equalling that of the azeotrope.

In another connexion some of us have been examining the extraction of nicotine from aqueous solution[9]. On turning attention to the distillation of aqueous nicotine solutions some interesting results have been obtained. A preliminary determination of values of k for a series of dilute (one liquid phase) solutions of nicotine in water indicates that the curve relating k with composition shows an inversion point (as described earlier). Accordingly, the existence of an azeotrope of nicotine and water would be probable. This work is being completed and the liquid-vapour equilibrium curve for nicotine and water will be constructed to confirm the existence of an azeotrope.

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Domhaill MacCárthaig.
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Sept. 15.

[1] "Principles of Chemical Engineering" (New York, 1927); 1937.
[2] *J. Amer. Chem. Soc.*, **36**, 1993 (1914).
[3] cf. Reilly and Hickinbottom, *Sci. Proc. Roy. Dub. Soc.*, **15**, 513 (1919).
[4] cf. also "Perry's Chemical Engineers' Handbook" (New York, 1934), p. 1154; and Walker *et al.*, *op. cit.*, 2nd ed., 1937, p. 533.
[5] Article on "Distillation", Thorpe's "Dictionary of Applied Chemistry" (London, 1940), vol. 4.
[6] *J. Amer. Chem. Soc.*, **50**, 3138 (1928).
[7] "Solubility of Non-Electrolytes" (New York, 1936).
[8] *J. Amer. Chem. Soc.*, **36**, 1803 (1914).
[9] "The Distribution of Nicotine between Trichloroethylene and Water", *J. Chem. Soc.*, 275 (1941).

Oogenesis in Adult Mice and Starlings

It has long been the general assumption that, at least in the higher vertebrates, the stock of oogonia and oocytes laid down in the ovaries during embryonic life is never afterwards increased, and that in the adult the waves of maturing eggs are derived from this stock which lasts the animal throughout its active sexual life. In 1923 this theory was challenged by Allen[1], who had observed in the ovary of the adult

mouse (*Mus musculus* L.) the formation of new oogonia from the mitotic divisions of the cells of the germinal epithelium. Depending on the plane of division, these mitoses resulted in the production either of new cells in the germinal epithelium or of new oogonia. Although the original theory is still widely held, much evidence confirming Allen's observations has now accumulated, and a review of present knowledge has been given by Swezy[2].

Investigations have been made which endorse Allen's statement that the mitotic activity of the germinal epithelium of the adult mouse ovary is a cyclic phenomenon. More mitoses are evident, and therefore more oogonia are produced, during the œstrous period than in any other period of the normal œstrous cycle. Allen did not, however, fully demonstrate how very intense and short-lived is this period of maximum production of new oogonia. In the strain of mice used in this laboratory, œstrus, as recognized by the typical vaginal smear, lasts for about forty-eight hours, and about thirty-six hours from the beginning of this period ovulation occurs. Œstrus is therefore divided into a long pre-ovulation period and a shorter post-ovulation period, the latter being equivalent to what Allen termed early metœstrum. Counts were made of the number of mitoses in the germinal epithelia of the ovaries of a series of normal mice in all phases of the œstrous cycle, and the results are given in Table 1.

TABLE 1.
Average numbers of mitoses in the germinal epithelia of ovaries of adult mice.

Period	Diœstrus 1st day	2nd day	3rd day	Pro-œstrus	Œstrus pre-ovulatn.	Œstrus post-ovulatn.	Met-œstrus
Mitoses	8	12	19	25	27	408	24
Number of mice	4	4	4	4	4	5	4

It is seen that a very sharp peak of mitotic activity is characteristic of the period immediately following ovulation, although there are also slight increases in the number of mitoses in both the pre-ovulation œstrous period and in metœstrus.

TABLE 2
Average numbers of mitoses in the germinal epithelia of ovaries of one-year-old starlings.

Month	April		May		June		July
Mitoses	0	5	30	8	0	0	0
Numbers of starlings	1	2	3	1	2	2	3

Oogenesis in many adult mammals is now an established fact, but little is apparently known about oogenesis in adult birds. During a study of the reproductive cycle of the starling (*Sturnus vulgaris* L.)[3] it was found that new oogonia are produced by the cells of the germinal epithelium, and further examination has indicated the presence of a cycle of mitotic activity similar to that of the mouse. The female starling when one year old usually lays one clutch of eggs, but when two or more years old it may breed twice in one season. Counts were made of the mitoses in the germinal epithelium of both first-year and older birds, and it was found that during the greater part of the year the germinal epithelium is quiescent. Mitoses, resulting in the production of new oogonia, are, however, common in the breeding season, and Tables 2 and 3 show the number of mitoses seen in the ovaries of starlings taken each fortnight from the beginning of April to the beginning of July.

TABLE 3.
Average numbers of mitoses in the germinal epithelia of ovaries of starlings of two or more years of age.

Month	April		May		June		July
Mitoses	0	4	34	11	22	2	0
Numbers of starlings	3	3	4	2	4	3	3

Ovulation takes place about the last week in April, and the greatest number of mitoses was observed immediately afterwards. In older birds, some of which ovulate a second time in early June, the counts of mitoses shown in Table 3 were made.

In addition to the wave of mitoses in early May, there is a second shorter and less intense wave coinciding with the end of the second ovulation in early June. By the end of June all activity of the germinal epithelium has ceased, and there are large numbers of small oogonia just below the tunica albuginea. These form a stock from which many of the next year's eggs are derived.

From these results it is evident that, both in the mouse and the starling, the mitoses of the germinal epithelium, resulting in the production of new oogonia, are at a maximum during very limited periods of the reproductive cycles, and in this respect the short cycle of the polyœstrous mammal is comparable with the yearly cycle of the bird. In both cases there is a sharp maximum of activity of the germinal epithelium in a short post-ovulation period. It appears probable that some factor which stimulates mitosis, and which is of an internal secretory nature, comes into full operation during this post-ovulation period. Further research on these lines is proceeding.

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Sept. 1.

[1] Allen, E., *Amer. J. Anat.*, **31**, 439 (1923).
[2] Swezy, Olive, *Quart. Rev. Biol.*, **8**, 423 (1933).
[3] Bullough, W. S., "The Reproductive Cycles of the British and Continental Races of the Starling (*Sturnus vulgaris* L.)", unpublished.

Function of Pyrenoids in Algæ

THOUGH attempts have been made from time to time to explain the function of pyrenoids in Algæ, exact knowledge on the point is lacking. Usually starch is deposited around the pyrenoids in a good many Chlorophyceæ, and G. M. Smith[1] holds that pyrenoids synthesize starch. In starch-free diatoms G. Karsten[2] remarks that one has scarcely seen the actual formation of oils in connexion with pyrenoids. But by growing *Rhopalodia gibba* and *Synedra affinis* var. *fasciculata* in 2 per cent glucose medium, fatty acid and glycerine medium, etc., I could get distinct grouping of oil-drops around the pyrenoids (Fig. 1), the first-formed oil-drops in these diatoms being invariably deposited round the pyrenoids. Similarly, by growing green filaments of Spirogyra in fatty acids and glycerine medium, oil is synthesized in the course of three days in the form of drops (Fig. 2) around the pyrenoids within the starch-sheath. Chemical analysis confirms the utilization of acids in the process as the amounts of acids decreased during the process. Filaments of Spirogyra undergoing decomposition, either in Nature or in artificial

culture, show the first formation of oil-drops around the pyrenoids within the starch-sheath as well as surrounding the sheath; here the starch-sheath becomes narrower and thinner—evidently oil is secondarily formed from the primarily formed starch-grains in the sheath.

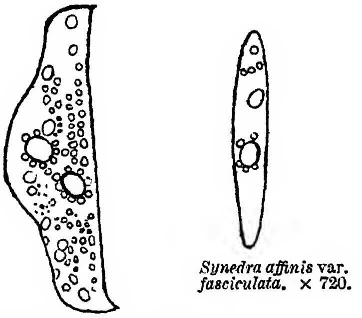

Fig. 1.

Thus, from these experiments it is held probable that pyrenoids serve as receptacles of appropriate enzymes for the syntheses of various food substances in such plants.

Fig. 2.

SPIROGYRA SP. PHOTOMICROGRAPH UNDER OIL IMMERSION LENS AND EYE-PIECE No. 5; OIL-DROPS AROUND THE PYRENOIDS WITHIN THE STARCH-SHEATH ARE MARKED BY WHITE LINES.

The central portion of the pyrenoids gives the protein test with Millon's reagent, where a very faint pinkish stain is visible under the oil-immersion lens. In plants (both lower and higher) lacking in pyrenoids pinkish vacuoles are always found inside the plastids, and food substances are usually deposited in connexion with them. These pinkish vacuoles are not found in old, disorganized or plasmolysed cells.

It is hoped to publish the details of the work soon.

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Carmichael Medical College,
Calcutta.
June 10.

[1] "Fresh Water Algæ of the United States" (1933).

[2] Engler's "Nat. Pflanzenfam.", 2 (1928).

Biography of W. H. Wollaston

IN 1931 I appealed in NATURE[1] for information for a biography of William Hyde Wollaston. Since then, probably all printed information of any importance has been supplemented by a large amount of unpublished material. In the collection of the latter, much of which is of great interest, I have received very generous help from many sources.

Various circumstances have delayed the work, but in a way I do not regret the delay, because from time to time fresh material has come to light. Only a few weeks ago a large collection of letters from Wollaston to E. D. Clarke (1769–1822), professor of mineralogy at Cambridge from 1808, was reported in a bookseller's catalogue, and is now in my possession. It is possible that other Wollaston material which readers of NATURE may know of is unknown to me. The dossier collected by Henry Warburton after Wollaston's death for the purpose of a biography was "lost", although I believe I have found a small fraction of it.

I am writing to record thus that the work is still in progress, and to issue one more appeal for information. Documents would be gratefully received by me, and would be returned by registered post as soon as copied; or, if correspondents would prefer that their documents were inspected under the ægis of an important library, Dr. T. Richards, librarian of the University College of North Wales, Bangor, where the section to which I belong of the Chemistry Department, University College, London, is enjoying hospitality, has kindly consented to take temporary charge of such papers.

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[1] NATURE, 127, 340 (1931). The date of Wollaston's birth was there stated as 1765 instead of 1766.

Men of Science as Administrators

IN a letter to NATURE (May 31), R. A. Jones has well expressed the molluscan tendency of men of science to grow a shell and stay in it, and the difficulty of acquiring the arthropod ability to moult into an administrative stage. This difficulty exists in Canada also, but to a lesser degree, I think, than in England. The reaction to strong criticism may often be an invitation to "come and do it yourself, you who know so much".

It seems to be agreed that the peaceful penetration of government departments by men of scientific training and experience is desirable. I submit that for men of science engaged in 'near-economic' work such penetration is not difficult, given the will and political conscience to do so. Men of administrative experience are vulnerable on the side of economic development. As to the lack of administrative experience among men of science, which, as Mr. Jones points out, is considered a serious obstacle, it seems to me that if a classical education is looked upon as a sound foundation for the conduct of the affairs of the native populations of Africa, then a knowledge of the quantum theory should be as good equipment for the administration of civilized communities.

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CONFERENCE ON INDUSTRIAL RADIOLOGY

ON September 24 the Industrial Radiology Group of the Institute of Physics held the first meeting since its inauguration, this taking the form of an afternoon conference at the Royal Institution, presided over by Prof. J. A. Crowther. The Conference was opened by Sir William Bragg who first spoke of the early days of X-rays, almost fifty years ago, before commenting on the many industrial uses to which the radiations are now put. He welcomed the formation of a group of workers interested in radiology and hoped it will be a success in sharing experience and knowledge and also in stimulating further interest in the subject.

Three papers were read before the conference, forming the basis for the following discussion. The first of these, given by Dr. W. Betteridge, and entitled "The Application of X-Rays to Industrial Problems", was a general review of the subject. The physical properties of X-rays important in radiology were briefly described, and led to a consideration of the factors involved in the production of a radiograph. The points to be considered in the choice of the different variables such as tube voltage, tube to film distance, etc., were considered, and the importance of blocking off, the use of filters, intensifying screens and diaphragms were briefly described.

Various fields in which radiology has proved of service were then enumerated—the examination of castings and welded joints was mentioned but left for the following speakers to treat in more detail, and the miscellaneous uses of the rays were then described under grouped headings. The examination of assembled structures was considered to be the most important use after the two already mentioned, these being examined for the presence and correct alignment of component parts. Radio valves, small ammunition, shell fuses, electric heater elements, sparking plugs, etc., were mentioned as examples and slides shown illustrating the types of defect looked for. Such examinations are frequently carried out by fluoroscopic means. The routine examination of food products, fire bricks, arc carbons, etc., was also mentioned, and stereoradiography for the location of defects and the measurement of wall thickness was described. The observation of objects in a furnace was illustrated among uses in a research laboratory, and microradiography was dealt with. This latter consists of the radiography of a very thin metal sample on fine-grain film with soft radiation, subsequent optical magnification of the radiograph giving the equivalent of a photomicrograph, and showing the presence of different phases by the different degrees of absorption; it was described as of particular value in the study of coring and segregation in a solid solution. The use of γ-rays in the examination of thick sections of heavy metals was mentioned.

A final section of Dr. Betteridge's paper dealt very briefly with the application of X-ray diffraction methods to industrial problems, reference being made to the recent symposium published in the *Journal of Scientific Instruments*. The Debye-Scherrer powder photograph was used to illustrate the different types of problem which could be dealt with, determination of the crystal structure, or its comparison with standards, being described for the identification of unknown materials in very small quantities, and the use of accurate parameter measurements for the analysis of alloys in solid solution and the measurement of elastic stresses was also mentioned. How the appearance of the diffracted lines could be used to yield information as to grain size, state of cold work or preferred orientation, and for the study of relaxation and recrystallization formed the closing section of the paper.

The next paper, by J. J. Gillespie, dealt with "The Applications of Radiography in the Inspection and Control of Welds". After a short description of the practice of welding and the bodies to which it is frequently applied, Mr. Gillespie dealt more fully with the methods used in the examination of welded joints in boilers and other pressure vessels. The need for careful preparation of the weld before examination was emphasized, in order that surface defects should not mask the internal faults for which search was being made; and it was pointed out that the marking out of the body before radiography should be systematically and permanently done, so that at any future date the radiograph of a particular section could be located. Dark-room technique must be maintained at a high standard since an otherwise perfect radiograph can easily be spoiled by faulty processing. The common types of defect were then enumerated, the chief classes being porosity, slag inclusions, lack of penetration and cracks, and slides were shown to illustrate the different degrees and forms in which these faults could occur. It was stated that a certain amount of uniformly distributed porosity or slag inclusions can be tolerated in a weld, particularly if the metal is of fairly thick section, but lack of penetration and cracks are more serious defects likely to result in stress concentration, and a high standard of acceptance has to be maintained. Mr. Gillespie stated that a generally agreed standard of acceptance is becoming a necessity.

The third paper, on the "Application of X-Rays to the Examination of Magnesium Alloy Castings", was contributed by P. M. Bailey. It was first stated that fluorescent screen inspection of magnesium castings is unsatisfactory, as it is, in general, quite impossible to detect microshrinkage, the characteristic fault of these alloys, and the minimum size of fault detectable is about seven times as great as that shown on a radiograph. The type of X-ray film found most suitable for this work has a fine grain, and the highest contrast is not found desirable; for this reason filters with an absorption up to 50 per cent of that in the casting itself are frequently used, although in general, filters are unnecessary for magnesium. Emphasis was laid on the use of a suitable viewing lantern, and modifications to commercial lanterns found necessary, such as the addition of blinds for reducing the area illuminated and the introduction of high-power lamps, were described.

Typical defects of magnesium castings were described, microshrinkage, which can reduce the tensile strength of the material from about ten to five tons per square inch, being paramount. The incidence of blow-holes and dross inclusions, both often due to faulty foundry technique, was mentioned, and it was pointed out that cracks, which, in the case of die castings, are

usually due to poor dies, can easily be missed if the direction of the X-ray beam lies far from the plane of the crack. The necessity of close collaboration between radiologist and foundry manager was emphasized, and the procedure followed by Mr. Bailey himself was described. The breaking-up of castings in order to confirm and supplement radiographic inspection is essential, especially for the detection of microshrinkage; this is helped by heat-treating the castings before breaking, the oxidation resulting making the microshrinkage more readily visible.

A lengthy discussion followed these papers and was contributed to by many speakers. Practical details, both difficulties which have been encountered and hints to overcome them, were mentioned, among the latter being the use of rubber cassettes which can be evacuated to hold intensifying screens in close contact with the film, the advantage of these being their flexibility, enabling them to be adjusted to close contact with irregularly shaped bodies; and the use of mercury for blocking off holes in an otherwise uniform plate. The most important point raised during the discussion, however, was the need for standardization of the acceptable limit for given types of fault. It was generally agreed that standards for welds would not be too difficult to formulate, particularly since welds are usually in material of uniform section and regular shape, but it would be much less easy to arrive at similar standards for castings. The responsibility for the determination of standards was discussed and there was agreement that the final decision should rest with the designer of a component, the function of the radiologist being to interpret the radiographs to the designer.

It was decided that the Radiology Group of the Institute of Physics is not in a position to undertake the preparation of radiographic standards, but Dr. L. Mullins, the secretary of the Group, pointed out that standardization is very necessary in other fields, and hopes, for example, that the Group will be able to put forward suggestions which will result in a reduction of the many different types and sizes of camera used in X-ray diffraction work.

TECHNICAL ABILITY AND THE WAR EFFORT

A PRIME necessity in a war-time economy is for the maximum and most efficient use of all the country's resources. Particularly necessary in this War is the full use of technical man-power. After two years of war, when it is implied by Government spokesmen that we still lack sufficient material to contemplate an offensive against the enemy, it is disquieting to learn that there still exists a widespread misuse of technical man-power.

At a national conference for members in engineering and aircraft industries, held at Birmingham on September 7 under the auspices of the Association of Scientific Workers, delegates stated that many industrial scientists and technicians are still working on peace-time problems. Others with insufficient work to do are being kept together as teams and find the Essential Work Order used to prevent release from their present firms and the transfer of their ability elsewhere. Delegates made it clear that this situation has arisen from the concern of some industrial firms with the problems of post-war competition. Speakers criticized the absence of any proper pooling of information. They spoke of production being held up while technicians completed designs or solved problems already dealt with by a parallel organization, and of the withholding of full technical information from designers of apparatus.

There was criticism of the scientific ability of some persons at present in charge of technical staff. A delegate from the aircraft industry spoke of technical leadership being in the hands of former racing drivers.

Many speakers felt that the combination of inefficient management, the concern of firms for private interests, the scheduling of overtime as a pretence of activity when there is insufficient work to do and similar experiences have given rise to a general apathy regarding production and that it is necessary for this to be broken down by close co-operation between management and employees.

The remainder of the conference dealt with working conditions in these industries. Cases were put forward of qualified men receiving less remuneration than workmen under their supervision. Strong exception was taken to the system whereby university graduates rated as student apprentices are put on to ordinary production work at nominal salaries. Speakers clearly felt that little improvement in the status of scientific workers would be effected unless the Association of Scientific Workers could establish a minimum salary scale for all grades of scientific and technical staff.

The Conference therefore passed the following resolutions:

(1) All technical staffs not fully engaged on the war effort or engaged on development in preparation for post-war competition should be transferred to other departments.

(2) Real pooling of technical information and facilities should take place between firms producing similar articles, and between Government departments and firms producing for them.

(3) All scientific and technical work should be under the direction only of persons with adequate technical experience and qualifications.

(4) There should be genuine co-operation between managers and workpeople to secure greater enthusiasm for the war effort.

(5) An attitude of vigilance should be adopted regarding the working of the Essential Work Order, so that it shall not be allowed

(*a*) to hinder the war effort by permitting managements to retain staff when their transfer would be in the national interest;

(*b*) to serve as an instrument of victimization of active trade unionists.

To carry this programme into effect the Conference proposed several points of action for the consideration of members of the Association, full details of which can be obtained from the Association of Scientific Workers, 30 Bedford Row, London, W.C.1.

THE NATIONAL RESEARCH COUNCIL OF CANADA

THE review of activities of the National Research Council of Canada for the year ending March 1940, which has now appeared, includes the report of the president, together with reports of the divisions and sections and reports of co-operative investigations, including the associate, joint and special committees.*

The president's report, referring to the re-alignment of work through the effect of the War, points out that many of the studies that were being carried out in peace-time proved of equal or greater importance in war-time, and the change over to a war-time programme involved very little departure from existing procedure. The Aeronautical Committee since the outbreak of war has been occupied almost exclusively on urgent military aviation problems, while the Radio Committee has undertaken a greatly enlarged and intensive programme directed exclusively by military considerations. With the outbreak of war, the Metrological Laboratory was considerably expanded to undertake the standardization of munition gauges. Scientific work of the Department of National Defence for the Services has included problems relating to the mechanical equipment, and other problems, of naval craft, such as the design and performance of hulls and the investigation of means of offence and defence in sea warfare. Research work for the Militia Service has covered war supplies, munitions manufacture, the examination of explosives and the provision of supplies for the troops, while for the Air Force the facilities of the Aeronautical Laboratories are used to determine the practicability of new designs of aircraft and engines, improvement in technique in construction and flight, engine performance and the effect of modifications in fuels and lubricants, etc. Other laboratories are being constructed outside Ottawa, and larger wind tunnels, both horizontal and vertical, are to be built, while a new model-testing basin will provide more adequate facilities for the study of ship and float design.

The National Research Council also maintained direct contact with similar scientific bodies in Great Britain, and since the beginning of the War the practice of exchanging scientific officers between Great Britain and Canada has been extended. The Section on Codes and Specifications is responsible for the preparation of commodity standards for Government Departments and for the development of a National Building Code as well as for general specification studies. The Research Plans and Publications Section, in addition to the maintenance of the Library, is responsible for the publication of the *Canadian Journal of Research*, the preparation of bibliographies on scientific subjects, and translations, and also conducts a research advisory service. With the recall of the president, Major-General A. G. L. McNaughton, to active military service, Dean C. J. Mackenzie took over the duties of acting-president in October 1939.

Dealing with the work of the main research divisions, the Division of Biology and Agriculture continued its work on plant growth factors, including the hormone treatment of seeds. These tests, carried out in co-operation with a number of organizations across Canada, indicated no appreciable benefit from such treatment of seeds when the hormone chemicals were incorporated in organic mercurial disinfectants or talc. Indolylacetic acid, however, proved effective in reducing injury by formaldehyde to germination in soil, and the dust method of applying synthetic hormone chemicals to plant cuttings had a further beneficial effect when the substances were used in combination with nutrient salts, sugar and organic mercurial disinfectants. Other work has been concerned with the propagation of forest trees from cuttings. Satisfactory results have been obtained with plant hormones applied as dust or in a mixture of equal volumes of sand and peat humus. Further work has been carried out on the standardization of the experimental baking test as well as studies on malt quality and the modification of malt. Among the work carried out on food storage and transport, the investigation of the canning of poultry and the development of rancidity in frozen pork during storage, as well as the curing of bacon by smoking in view of the dearth of refrigerated shipping space available, may be mentioned. Other work has been concerned with the control of storage conditions and also with the storage of blood for transfusion purposes. Statistical studies have been made of the effect of dust seed treatment with indolylacetic acid on the growth and yield of barley under closely controlled conditions.

In the Division of Chemistry, a major project was concerned with the preparation of ethylene oxide by direct oxidation of ethylene by air over catalysts, and some catalysts have been prepared which show sufficiently high activity and specificity to indicate that the process might be more practical than the chlorohydrin process for the manufacture of ethylene glycol. A new laboratory has been equipped for the study of synthetic resins and plastics, while the electrochemical laboratory has continued work on the corrosion of metals by used lubricating oils, the corrosion of metals and coatings by 'leaded' petrol under storage conditions, and a preliminary investigation of the corrosion of metals by hot and cold domestic tap waters and by softened laundry water. Investigations in the field of detergency as applied to laundering and dry-cleaning have been continued, as well as research on the possible harmful effects of certain textile finishing agents and methods of determining sizing and finishing compounds on cotton fabrics. In the Paint Laboratory, increasing attention has been given to protective coatings for use on aircraft, military vehicles and other equipment for war purposes.

The Division of Physics and Mechanical Engineering has been concerned with investigations on fatigue in aircraft propellers, the temperature control of refrigerator cars, development work on photographic apparatus for the Royal Canadian Air Force, and on the application of spectrochemical methods of analysis to agricultural problems.

Of the associated and joint committees, the Associate Committee on Aeronautical Research has been responsible for further work on the cathode ray compass tests, on the oil dilution system for cold-weather starting of aeroplane engines, the development of the apparatus to study vibrations in aircraft structures, fatigue of metal propellers and aircraft ski research.

Under the Advisory Committee on Field Crop Diseases, research in Alberta has indicated that seed

* National Research Council of Canada. Review of activities for the year ended March 1940. N.R.C. No. 976. Pp. 155. 75 cents.

treatment with formaldehyde is ineffective for preventing smut contamination. Copper carbonate and chloride were more effective, but the organic mercurial dusts were the best protectors. Research in Manitoba on liquid and dust fungicides for smut control showed that dust failed to control smut in oats and barley although the failure may have been due to the method of treatment given. Satisfactory control in wheat was obtained with solutions of organic mercurial compounds.

In work under the Associate Committee on Grain Research at the University of Alberta preliminary comparisons of the relatively injurious effects of the three organic mercury dusts, New Improved Ceresan, Laytosan and Lunasan, on wheat indicated that the first was more likely to cause injury in overdoses than the others. Further evidence was obtained indicating that treatment of seed wheat with formaldehyde renders it more susceptible to mould damage than untreated wheat, although the damage was apparently reduced by addition of certain fungicidal dyes and organic mercurial compounds to formaldehyde solution.

Progress has been made with breeding projects aimed at the development of drought-resistant varieties of wheat. Work on the development of rust-resistant smooth awned barley of good malting property has continued.

Under the Associate Committee on Medical Research a study is being made of the relation of certain food factors to the development of cancer, and attempts to prepare a synthetic chemotherapeutic agent for the treatment of tuberculosis and studies of the relation of certain dietary deficiencies and physical factors to the development of arthritis are in progress.

Two meetings have been held of the Canadian Committee on Oceanography, established in March, 1938,. while under the Associate Committee on Parasitology studies of the enzyme inhibitors of Ascaris and of the anthelmintic action of phenothiazine have been carried out. In addition to the studies of the anthelmintic action of phenothiazine in sheep, a method of administration has been worked out by critical testing and a test is being conducted on its effect on a flock of cull lambs.

THE HELIUM METHOD FOR DETERMINING THE AGE OF ROCKS

By N. B. KEEVIL,
DEPARTMENT OF PHYSICS, UNIVERSITY OF TORONTO

THE potentialities of radioactive methods of determining the ages of rocks, minerals and meteorites are so great that much time, money and effort have been expended in age research during the past decade. The supplement to the chemical method of the more elegant physical method of lead age determination from isotopic abundances has done much to establish confidence in the lead time-scale; but more hope has been held for the helium method because of its promised application to a great variety of geological materials rather than to a limited group of rare minerals.

It is now evident that the 'apparent age' or helium index calculated by the helium method is usually considerably lower than the age expected from geological and lead age data. Only in rare cases does the helium index seem to be concordant with the lead time-scale. This would not be so serious geologically if helium indexes were reasonably consistent, for it is not so much the absolute age as the sequence and relative time intervals which are of importance in geological problems. However, a survey of one hundred and fifty determinations on rocks has shown that there is only a one-to-one chance of finding the age of a basic rock within one geological period, that there is a still smaller chance of determining the age of a granitic rock, and that the results obtained for porphyries and lavas are meaningless from the point of view of age.

The discovery that differing values of the helium index are obtained for the different minerals constituent in rocks[1] led to the theory that the low results were due to selective loss of helium in minerals. Results recently obtained for one hundred and fifty minerals have shown a variation in the ratio of experimental age (helium index, I) to the expected age, A, from mineral to mineral and from rock to rock. No one mineral has been found to give uniform results. Since more than ninety per cent of the four hundred age determinations made to date show lower values than expected, the explanation that the variations are due largely to non-uniform loss of helium seems a logical one, and hence I/A may be termed the helium retentivity.

The results summarized in Table 1 show that the retentivity varies by a factor of 2500, but if the high values are excluded, most of the average values, and the probable values of retentivity obtained from distribution curves, fall within the range 0·3–0·6.

TABLE 1. HELIUM RETENTIVITIES OF ROCKS AND MINERALS

Type of sample	No. of samples (Keevil)	Helium retentivity			No. of samples (others)
		Range (Keevil)	Average* (Keevil)	Average† (others)	
Granitic rocks	34	0·02–0·86	0·25	0·35	6
Basic rocks	18	0·10–1·93	0·44	0·45	69
Porphyries and lavas	22	0·01–1·08	0·12	0·36	9
Quartz	14	0·04–1·22	0·25		0
Magnetite	10	0·24–12·3	0·46	0·93	18
Oxides	6	0·11–0·59	0·32	0·25	17
Feldspar	25	0·02–0·46	0·20	0·25	2
Femics	37	0·05–3·84	0·57	0·45	4
Silicates	22	0·12–3·63	0·41	0·34	29
Oxy-salts and halides	12	0·03–24·6	0·45	0·38	10

* Excluding 14 values indicating excess helium.

† Excluding 18 high values from data by Strutt, Holmes, Dubey, Kano, Davis, Lange, Urry, Goodman, and Hurley.

No significant disagreement exists between my results and data obtained by other observers. Rocks containing a glassy matrix are not comparable with crystalline rocks, since helium diffuses through glasses

much more readily, and the discrepancy in the case of magnetite is discussed below.

Attempts to apply corrections on the basis of average helium retentivities have made little improvement in the accuracy of dating, although such correction does tend to place the helium ages calculated for different types of specimens on a more common basis. At the present time it seems that such corrections do not provide 'ages' of sufficient accuracy for use in geological correlation. A consideration of the local effects of metamorphism, and a more general plot of retentivity against expected geological age, show the discrepancies to be due in part to the variation in retentivity of minerals with geological history. It is fairly definite that low values of I/A are caused by metamorphic changes, deuteric action, some mineralization processes, and by weathering. In a series of Algoman hornblendes from one area, a relationship between the degree of alteration and helium index was found. It is also apparent that loss of helium may be caused by crystal imperfections, localization of the radioactive elements, and by interruptions in structure.

Two possible alternatives remain: first, the use of perfect minerals, if such can be found, and secondly, the correction of helium indexes by means of characteristic equations or curves for each mineral, such as retentivity-alteration curves. I have had some success with the second method, but it is doubtful whether a generally useful method can be developed. It is also uncertain whether any crystal can be said to be perfect so far as retaining its radiogenic helium is concerned; and the chance of its containing excess helium renders the result subject to error in any case.

Although it has been suggested that magnetite generally retains most of, if not all, its helium, and so gives reliable helium ages[2], results obtained in this laboratory indicate magnetite to be no better than some other iron minerals. Although some samples have appeared to give ages consistent with the lead time-scale and geological data, others have shown pronounced loss of helium, and a few have shown evidence of large amounts of extraneous helium. Furthermore, age determinations on other minerals separated from magnetite-rich samples have shown discordant results in all cases, the helium indexes frequently being higher than those for magnetite. The few examples given in Table 2 show the unreliability of using helium indexes of magnetite as criteria of age.

TABLE 2. SOME RESULTS ON MAGNETITES

Locality	Helium index, I	Expected age, A	"Retentivity", I/A
Magnet Cove, Ark. ...	42	150	0·28
Bushveld Complex, Africa	39,200	575	6·53
Port Henry, N.Y. ...	230	600	0·37
Franklin, N.J.	181	600	0·29
Yellowknife, N.W.T. ...	2,640	575	4·6
Yellowknife, N.W.T. ...	16,500	575	28·7

At the present time, insufficient is known of the causes of the discrepancies to permit correction of helium indexes, and while some mineral specimens give a value of I/A of unity, one cannot be confident from preliminary examination of the mineral that the 'correct' age will be obtained. It must therefore be concluded that the helium method in its present stage of development is not generally reliable as a means of geological correlation.

[1] Keevil, N. B., *Amer. J. Sci.*, **36**, 406–16 (1938); see NATURE, **143**, 32 (1939).

[2] Hurley, P. M., and Goodman, C., *Bull. Geol. Soc. Amer.*, **52**, 545–60 (1941).

FORTHCOMING EVENTS

MONDAY, OCTOBER 13

THE FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 3 p.m.—Mr. James Mackintosh: "Feeding Livestock under War Time Conditions".

TUESDAY, OCTOBER 14

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.45 p.m.—Mr. W. J. Jones: "Light and Lighting—A Forward Outlook" (Presidential Address).

WEDNESDAY, OCTOBER 15

INSTITUTE OF FUEL (in the Connaught Rooms, Great Queen Street, Kingsway, London, W.C.2), at 2.30 p.m.—Mr. W. M. Selvey: "The Hundred Thousand, an Engineer's Philosophy" (Presidential Address). Dr. Clarence A. Seyler: "Recent Progress in Coal Petrology" (Melchett Lecture).

THURSDAY, OCTOBER 16

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. I. M. Heilbron, F.R.S.: "Some Aspects of Algal Chemistry" (Eighth Hugo Müller Lecture).

FRIDAY, OCTOBER 17

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Annual General Meeting. Mr. W. A. Woodeson: Presidential Address.

SATURDAY, OCTOBER 18

NUTRITION SOCIETY (at Cambridge).—Conference on "The Evaluation of Nutritional Status". (See page 433 of this issue.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL of Melton Mowbray and District County Technical College—W. A. Brockington, Esq., Grey Friars, Leicester (October 14).

PSYCHOLOGIST—The Hon. Secretary, Cheltenham and County Child Guidance Clinic, Education Department, Municipal Offices, Cheltenham (October 15).

LECTURER IN THE DEPARTMENT OF PHARMACY—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

ASSISTANT CONTROLLER OF TELECOMMUNICATIONS (ENGINEERING) for the Malayan Postal Service—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9795).

LECTURER IN PRINCIPLES OF EDUCATION at Victoria College, Belfast—The National Froebel Foundation, 2 Manchester Square, London, W.1.

INDUSTRIAL CHEMISTS (preferably with works experience)—The Director, British Launderers' Research Association, The Laboratories, Hill View Gardens, Hendon, London, N.W.4.

ASSISTANT MISTRESS TO TEACH ELEMENTARY SCIENCE AND MATHEMATICS—The Headmistress, Day Technical School for Girls, Fort Pitt, Chatham.

FIRST CLASS HONOURS GRADUATE IN CHEMISTRY, WITH SUBSIDIARY PHYSICS—The Principal, University Correspondence College, Burlington House, Cambridge.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Technical Report, Reference A/T83: Mechanical Behaviour of Bitumen. By W. Lethersich. Pp. 28. (London: British Electrical and Allied Industries Research Association.) 15*s*. [179

Other Countries

Proceedings of the United States National Museum. Vol. 90, No. 3108: Synopsis of the Tachinid Flies of the Genus *Tachinomyia*, with Descriptions of New Species. By Ray T. Webber. Pp. 287–304. Vol. 90, No. 3113: Pamlico Fossil Echinoids. By Willard Berry. Pp. 443–446+plates 63–65. (Washington, D.C.: Government Printing Office.) [179

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VOL. 148 No. 3755

NATURE

SATURDAY OCT. 18, 1941

FOUNDATIONS OF A NEW WORLD ORDER

THE Atlantic Charter has rightly been recognized as a political offensive of the first order. It is the starting-point for far-reaching and greatly intensified political warfare. Even more important, there is scarcely one of the eight points that is not a challenge to clear, fundamental and constructive thinking. That in certain respects most of the eight points require elaboration, if not elucidation, does not detract from the significance and value of the charter they constitute.

The many attempts already made to outline the basis of a new order which affords an adequate reply to that which the Nazis seek to impose on a prostrate Europe must therefore be given careful consideration. Two such recent efforts may be commended to the attention of scientific workers for their contribution to clear and constructive thinking. The first of these, by Prof. E. H. Carr, in the Democratic Order series of pamphlets*, deals particularly with the issues involved in the principle of self-determination and nationality, and should help to clarify thought about the second and third points of the Charter. The second, Mr. C. B. Purdom's "The New Order"†, goes even deeper into the social and economic changes involved in the establishment of any new order which worthily embodies the ideas of the fourth, fifth and sixth points of the Charter.

Prof. Carr's pamphlet derives its main value from its critical exposition of some of the fallacies which have initiated policy in the past, although he concludes with various constructive suggestions. He directs attention to the limited validity of the supposed coincidence between the principle of nationality and that of self-determination. Generally speaking, this is valid only for the limited area of western Europe, and self-determination should accordingly be carefully disentangled from those misleading associations with nationalism which nineteenth-century thought fastened upon it. It must be recognized in future that the self-determination of small nations is incompatible with unbridled economic power and complete economic independence.

Furthermore, Prof. Carr points out that the development of military technique and the conditions of modern warfare have broken down the conception of the independence of small States based on the principle of self-determination. In modern conditions of warfare, a small State cannot defend its independence against a great Power except by methods which in themselves constitute

* The Future of Nations: Independence or Interdependence? By E. H. Carr. (The Democratic Order, No. 14.) Pp. 64. (London: Kegan Paul and Co., Ltd., 1941.) 1s. net.

† The New Order. By C. B. Purdom. Pp. xvi+286. (London: J. M. Dent and Sons, Ltd., 1941.) 7s. 6d. net.

a surrender of military independence. Interdependence has become an inescapable military necessity. Neutrality has been virtually nullified for small nations in proximity to the theatre of war, both in the military and in the economic sphere. The small Power can in fact only survive by seeking the permanent alliance of a great Power.

Prof. Carr maintains that the failure of the settlement of 1919 was due, first to disregard of the economic factor, and secondly to neglect of the way in which military conditions had thus qualified self-determination. Moreover, many factors already introduced in the present War tend further to complicate the question of self-determination and independence. The offer of Great Britain to form a union with France, and also the Atlantic Charter, are the most striking examples of the extent to which nations have been prepared for close military and economic co-operation for the tasks of peace. The Inter-Allied meetings in London, a composite army, a navy and an air force in which units of different nationalities are embodied under a single command, the possession by one country of naval or air bases on the territory of another—all these are arrangements which need not disappear with the war. The Eight Points show that the democratic leaders have no intention of returning to the anarchy and confusion that marked the life of the world between the two wars.

Tentatively, Prof. Carr concludes, therefore, that we must discard the nineteenth-century assumption that nation and State should normally coincide, and lay far less stress on the absolute character of the right of self-determination and far more on its necessary obligations. Neglect of these correlative obligations was one of the cardinal errors of 1919, and Prof. Carr indicates how from this flow two lines of development towards international order: recognition of the need for a larger unit than the present nation for military and economic purposes and, within this unit, for the largest measure of devolution for other purposes, and recognition that the right of national self-determination can be valid only within the limits of this necessity for military and economic concentration.

Acceptance of these principles clearly involves a revolution in our whole thinking about neutrality, economic policy and defence, and that revolution must commence before the fighting ends. The lines of policy suggested by Prof. Carr are in fact well calculated to gain time for such a transformation of thought to occur. First, he urges the vital importance of maintaining, for the organization of peace, the forms of co-operation already established by those united in the struggle against Nazism. This machinery of interdependence and co-operation should be extended to other countries by an empirical process based on practical needs and possibilities. In the same way the constitutional forms of such co-operation must be determined, not theoretically according to some *a priori* conception of league, alliance or federation, but empirically as the outcome and expression of a practical working arrangement. The establishment and maintenance of *de facto* co-operation are far more important than the drafting of constitutional rules to regulate. At the present stage, interdependence is the practical problem of surrendering the habit of framing our military and economic policy without regard for the needs and interests of other countries.

In spite of the entirely different approach, Mr. Purdom's much more ambitious study gives a strikingly similar outline of a new order. The greater part of his book is indeed occupied by a comparatively detailed outline of a new order in Britain, but like Prof. Carr, he insists in the first place on the need for a new attitude, for a revolution in thought and the readiness to sacrifice old prejudices and ways of thought and living. The new order he outlines is built up of nations or States in which this changed outlook has already occurred, and the evolution of international institutions, whether in Europe or in the world at large, proceeds from the nation as model and as unit.

The structure of the new order conceived by Mr. Purdom is association in the State, society and nation, and it is to be built up through the recognition of the functional principle. International co-operation becomes practicable through the creation of functional organs within the nation and through the removal of sovereign power. The conversion of the British State into a functional organ involves the separation of economic and cultural from civic and political objects, those functions of the State now concerned with industry and trade being entrusted to an economic organ and those concerned with education, health, art and science to a cultural organ. The State would then be concerned strictly with its ancient functions of legislation, justice and order.

Mr. Purdom's proposals for the transformation of British institutions into a functional social order are detailed, and involve new conceptions of politics, of city life and of the value and significance of local government, as well as a new emphasis on cultural institutions; the removal of trading services and education from civic government gives a new aspect to regionalism. In the structure tentatively outlined, there are three functional chambers, of which the Civic Chamber would continue the specific characteristics of the House of Commons for legislation and retain its name and rules and forms. The House of Lords would be transformed into the Senate, its members appointed

for life from among men and women distinguished in religion, science, art, letters, education, medicine, economics and civic affairs, and there would also be a Senate of Women and a Senate of Youth with consultative and advisory functions only.

The main element in the economic life of this new order would be the Economic Chamber, to which all the economic and industrial functions of the State would be transferred; it would be responsible for the reorganization of the economic life of the community, and the creation and supply and distribution of the goods and services required. This Economic Chamber would be concerned with all industries, primary and secondary, with power, transport, postal communications, agriculture, fisheries, shipping, distribution and banking. The individual, competitive, or monopolist units in every industry and service would be replaced by guilds composed of all engaged in the industry or service in whatever capacity. Through this system Mr. Purdom considers a new sense of vocation could be developed and a new standard of scientific production attained. Besides the guilds, the Chamber would work through a series of economic boards which would deal with proposals affecting the guilds or the Chamber, and consider and review regulations made by the guilds or legislation affecting them.

Parallel with the Economic Chamber, Mr. Purdom proposes a Cultural Chamber responsible for the bodily, mental and spiritual welfare of the community. This Chamber would consist of representatives of the churches and the various cultural guilds covering science, art, education, recreation, publication, etc., for which councils would also be formed through which the Chamber would work. These cultural organs, which unlike the economic organs, would not be limited to those less than forty-nine years of age, are intended to overcome the defects of specialization while enabling science and other cultural factors to exert their full humanizing influence on society.

Both in the economic and in the cultural sphere these institutions are visualized as reaching down into a system of co-ordinated local guilds in which the individual and the locality have full opportunity to make their own contribution. Similarly, while a Central Planning Board under the Minister of Planning as chairman, and formed jointly from the Economic Planning Board and the Board of Cultural Planning, would take care of the central planning required to avoid overlap and ensure consideration of all factors in national planning, it is from these same individual economic or cultural units that Mr. Purdom visualizes the beginning of effective international co-operation. The structure he contemplates for Britain would have its counterpart in the Dominions, from the political, economic and cultural chambers of which there would be formed three distinct federations: a Commonwealth Political Federation, a Commonwealth Economic Federation and a Commonwealth Cultural Federation. In addition, a Commonwealth Planning Council would be concerned with the higher direction of Commonwealth policy. The Colonies might be brought into the system as a commonwealth responsibility under a Commonwealth Colonial Council.

These Commonwealth federations are Mr. Purdom's model of the new world institutions. Functional federation on such lines, including a federal union of States with a federal defence council, federal court, currency council, colonial council and political planning council, a federal economic union, a federal cultural union, embracing a scientific council, a council for art and a planning council for culture, and federal planning institute, first for Europe and then extending to a world union on the same lines, offers, he considers, the most hopeful solution of establishing a European and a world order giving full satisfaction to human aspirations and ideals, and in which liberty and individuality would be reconciled. It offers, too, a solution of the problem of the place of Germany in a new Europe, and many of the changes he suggests can be built on developments or institutions already brought into existence by the War.

Mr. Purdom's proposals are no doubt ambitious—many would say visionary—but there is more to commend them than even the fact that some of his suggestions are taking crude shape under the stress of war. By far the most successful international co-operation of the last two decades has been on functional lines, and by concentrating on such developments, encouraging through them the development by education, through world planning and through cultural or economic contacts, of a widespread world consciousness, while preserving, as Prof. Carr insists, the institutions of co-operation established to serve our immediate tasks of defence or offence, it may be possible to move forward to a more concrete and formal organization when the time is ripe. Meanwhile, Mr. Purdom's proposals at least merit serious and critical examination. They indicate one way in which the points of the Atlantic Charter might be translated into action. Whether the particular proposals he details are adopted or not, no new order embodying the spirit of that declaration and safeguarding the four freedoms of mankind will ever be elaborated save by utilization of creative energy, and by readiness to face change and to accept sacrifice and responsibility. It is in that spirit alone that the immense opportunities that the War has brought can be seized and turned to the building of a new order, a new society of free men and free peoples.

REASON AND THE 'NEW ORDER'

Ideals and Illusions
By L. Susan Stebbing. Pp. xiii+206. (London: Watts and Co., Ltd., 1941.) 8*s*. 6*d*. net.

THIS book, which is written by a philosopher, deserves to be widely read. It could be used by 'advanced groups' studying the problems of the post-war world. It is suitable also for the isolated student and especially, I think, for the scientifically trained and for religious people.

It is not a very easy book to read. Some re-arrangement of the chapters might clarify the argument, but the difficulty arises rather from the nature of the subject than from faults in authorship.

The object of the book is to examine one of the three important causes that have led to the present "profound failure" of civilization. The method adopted is that of rational or Socratic criticism. The part played in Plato's Dialogues by his acquaintances is taken by a large number of leaders of modern life: political, economic, philosophical and religious. One by one, they are brought into the discussion by means of extracts from their books or speeches. Interesting results follow the rational criticism of their words.

The argument of the book is based upon the dictum that there are "three important factors that determine social change: economic structure, the possession of power—especially naked power—and ideas".

Prof. Stebbing deals only with the last of these factors. "The modern world over-emphasising power has neglected the significance of ideals." An ideal is described as being "something considered to be worth having", an idealist as "one who is influenced in his actions by his ideal". No description is given of an illusion, but it appears that an ideal that will not withstand rational criticism or is impractical, does not influence conduct, or is evil in its social consequences, is an illusion.

The close connexion between good ideals and good social conduct is repeatedly stressed—at least by implication: the need for a sound criterion of the rightness or wrongness of an action —the need, that is to say, for a sound basis for morals—is emphasized again and again.

Some people attack idealists because they believe them to be utopians and visionaries, but the attack may be due to verbal misunderstandings or to the careless use of words. Again, misunderstanding may arise from a confusion between ideals and illusions. Even the most ardent of the realists, from Machiavelli to Hitler, have possessed and have pursued ideals. It is an illusion to suppose that realists have no ideals: the question is whether their ideals are good or bad. Another illusion is to hold "that unless there be a goal for man beyond and outside the historical process, our lives are without significance and futile" and, in that case, that there "remains no basis for morals". But "many spiritual excellencies are valuable for their own sake" and do not depend upon a future life.

Everything points therefore to the "need for reflection" in order that we may be able to distinguish ideals from illusions. "The unexamined life is not a life worth living for a human being", said Socrates.

The modern tendency to disparage reason is considered. The 'retreat from reason' is found to be due, in part, to a longing for certainty and for absolute moral standards. Certainty is an illusion; in seeking for it we "always over-simplify our real problems".

Next we consider the "democratic ideal". A starting-point is found in a sentence in the American Declaration of Independence, "that Freedom and Happiness are the inalienable right of all men". The ideals of freedom and happiness are examined. The divergent ideals of democrats and totalitarians are made more clear to us. After that we consider an illusion, that happiness is irrelevant to the good life since, as some Christians have asserted, poverty, pain and suffering are disciplines for the soul. But "if our sensibilities are unblunted, we cannot ignore the tragic happenings in our world. Not to ignore them is to be forced to do something about them; and to do something, it is first necessary to make clear to ourselves our political ideals." Another common illusion is to suppose that democracy can be achieved simply by "playing the game".

Once again we examine the conflicting ideals of the democrat and the totalitarian, and as we do so we encounter the illusions that arise from the careless use of abstract words like war and poverty. At this point the author suggests a device by means of which some of our illusions may be evaded. She suggests that the main abstract word in a sentence should be translated into an "equivalent sentence" composed of corresponding but less abstract words. When this has been done, it is usually not difficult to discover to what extent our thinking has been confused by the abstract words. In this manner we shall learn to speak plainly and think more clearly. Abstract words such as 'conscience' and 'conscientious' are next examined.

Finally, we return to a point raised earlier in the book. This is what the author calls the "Last

Illusion", namely, the idea that morality is dependent (as most, but not all, Christians hold) upon a belief in *personal* and *conscious* immortality. This last chapter seems to me to fall below the standard set by the rest of the book both in clarity and significance. The argument aims at showing that a belief in personal immortality is an illusion and that a rational basis for morals can be found without invoking this belief. But it may be asked whether a *rational* basis for morals is sufficient for our present tragic circumstances. It seems to me that what is chiefly necessary is a sound *conative* basis for morals, that is to say, an adequate and an enduring 'drive' towards right conduct. May it not be that, even if a sound rational basis for morals can be found within the time-space order, adequate and persistent moral *drives* can only be found within an eternal order? A. N. Whitehead has said: "What Plato thought, Christ did." Within the difference that existed between Plato and Christ is to be found (as it seems to me) the 'drive' that the modern world needs. Dr. Stebbing asserts that a sound basis for morals can be found in "metaphysical materialism". I venture to doubt it. At least we should require an "equivalent sentence" for these highly abstract words before forming an opinion. Perhaps paper economy is responsible for the vagueness of her final chapter—or it may be that my illusions or her illusions are responsible for it.

I regret that the book has no index, not even an index of quotations. This last omission seems to be a serious fault in a book of this kind. But I hope that I have sufficiently commended a valuable discussion of an important topic.

HOWARD E. COLLIER.

PLASTICITY IN METALS

The Metallurgy of Deep Drawing and Pressing
By Dr. J. Dudley Jevons. Pp. xvi+700+164 plates. (London: Chapman and Hall, Ltd., 1940.) 50*s*. net.

THE modern use of metals and alloys is dependent to a very large extent on their plasticity, which allows them to be worked into useful forms in the solid state, at ordinary or at raised temperatures, by methods causing plastic flow. It is not only in course of manufacture that this plasticity is useful, since the same property is a safeguard against sudden fracture under stress. Possibly the most striking example of the importance of plasticity in metals is the hot-rolling of vast quantities of steel into many different forms, but the pressing of metal sheet into finished shapes at atmospheric temperatures is also now a great and expanding industry. To give one example, the present-day motor-car body is essentially an assemblage of sheet steel pressings.

In the past, the hot and cold working of metals were both looked upon as primarily the province of the engineer, no doubt because of the engineering knowledge demanded in the design, construction and operation of the powerful rolling mills, hydraulic presses and other machines used. More recently, the metallurgical problems arising have received a larger share of attention. Organized co-operative investigations are now in progress in Great Britain on the rolling and on the deep drawing of metals. Prof. H. W. Swift, who has written a foreword to this book, has for some time been conducting a section of these researches on deep-drawing problems, and has, in particular, made advances in methods of determining the capacity of metal sheet for undergoing deep-drawing operations satisfactorily. "Deep" drawing imposes severe plastic deformation on sheet metal by means of a punch and a die in a press. The production of a brass cartridge case from a flat disk in successive drawing operations, with intermediate annealings to restore the plasticity lost in the hardening caused by cold work, illustrates the extent to which such cold-working operations can be carried in deep drawing.

Dr. Jevons has made the subject of deep drawing peculiarly his own and has taken full advantage of his special opportunities for investigating its application on the large scale. He has produced a comprehensive treatise in which none of the metallurgical aspects of deep drawing is neglected. He has indeed gone outside this field in giving excellent concise descriptions of the manufacture of the two chief materials of deep drawing, brass and steel sheet. While far more adequate accounts of, for example, the iron blast furnace are naturally to be found elsewhere, those engaged in deep drawing, for whom the book is mainly written, will be helped by the descriptions of the manufacture of the materials the properties of which are so important to them. Mild steel of the softest grades and annealed brass such as 'cartridge brass' containing about 70 per cent copper, 30 per cent zinc are specially suitable for deep drawing because of their very high plasticity.

The cold pressing of flat sheets into various forms is such a quick, convenient and economical way of

producing relatively intricate shapes that it is often applied to the utmost limit of the deformation the sheet will stand. Thus there is a never-satisfied demand for still better deep-drawing properties. Dr. Jevons has rightly given much space to the questions, less simple than might be thought, of what constitutes good deep-drawing properties in the various materials used, how these properties may be controlled, measured and specified, the many causes of defects and failures occurring in drawing or as a consequence of it, and means of overcoming these troubles. In this section special chapters are devoted to the season-cracking of brass resulting from internal stresses remaining after drawing (a trouble which should occur less frequently than it does as methods of prevention are well established) and stretcher-strain markings in steel. These markings, a form of 'Luder's lines', caused by local 'necking' under the tensile stress imposed by drawing, constitute a difficulty in the drawing of mild steel which is not easily surmounted. Presses, tools, lubricants, new applications of deep drawing, and the deep drawing of metals other than brass and steel are the headings of other chapters each dealing adequately with its subject. The avoidance of defects and failures by improvement in design of the pressing, in pressing operations or in the drawing qualities of the metal sheet is discussed in an impartial and authoritative manner.

Plasticity in metals is a property of the individual crystal. Dr. Jevons attaches full weight to such factors as size and orientation of the crystals and discusses 'directionality' in an illuminating way. The mode of deformation of metals, even in relatively simple and well-defined conditions, and the effects of such permanent deformation still present many obscurities. The scientific study of the severe and intricate plastic flow involved in deep drawing, of the changing conditions of stress and strain, and of the complex effects resulting, is full of difficulties, and practice rests mainly on empirical knowledge. Nevertheless, Dr. Jevons considers that there is urgent need for a much wider application to deep drawing of scientific investigation and control, which have already solved serious problems in this field.

Although the book is a very substantial volume Dr. Jevons has compressed his encyclopædic knowledge of the subject into manageable compass and has contrived to make it thoroughly readable. All the industries concerned and all those who have occasion to take a scientific interest in any aspect of deep drawing have reason to be grateful to him for this masterly treatise. Its appearance during the War has been most opportune because of the extent to which deep drawing is employed in the manufacture of aircraft, ammunition, transport vehicles and innumerable other war requirements. The lavish illustrations add to the value of the book, and the way in which it is produced is worthy of the excellence of its contents.

THE BARTRAMS: BOTANISTS AND EXPLORERS

John and William Bartram, Botanists and Explorers: 1699–1777, 1739–1823

By Ernest Earnest. Pp. vii+177+2 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1940.) 12*s*. net.

THIS book is delightful reading. It tells of pleasant people in happy times, for it is mostly about Philadelphia in Benjamin Franklin's day. John Bartram, member of the Society of Friends and poorly educated in a village school, bought a piece of rough land on the Schuylkill River, hard by the city, in the year 1728; there he built his house, drained his land and won his way to prosperity. Meanwhile he planted a garden and learned botany, became a friend of Benjamin Franklin, and signed his name next to Franklin's own on the Founders' Roll of the American Philosophical Society. He came in close touch with Peter Collinson, and was the chief source of new and rare American plants for him and his many gardening friends; sent pine-cones to the Duke of Norfolk and seeds to Philip Miller and dozens more; was dubbed king's botanist for the American Colonies by George III, made a member of the Royal Academy of Sciences of Stockholm, and called by Linnæus the greatest natural botanist in the world.

He was indeed a remarkable man, and his son William was no less remarkable in his own way. When "Billy" was a schoolboy—"botany and drawing are his darling delights", said his father, "and I'm afraid he can't settle to any business else". The forecast came true. But William Bartram learned to draw exquisitely, knew his plants and his birds, was loved and trusted by the Indians, travelled far and wide and constantly, and at last wrote a famous and beautiful book. To write English undefiled was no rare accomplishment in the Quaker city, but Bartram wrote his "Travels" in such a style as influenced Chateaubriand and delighted Wordsworth and Coleridge himself. From Bartram, Wordsworth took his Indian scenes for "Ruth", and Coleridge

got his sacred river, with its "caverns measureless to man". As Coleridge says in his "Table Talk", "the book was written in the spirit of the old travellers". Wordsworth's "pulse of the machine" was Bartram's own "pulse of nature"; and what Bartram conceived as an "impulse" controlling the life of the plant grew in Wordsworth to "One impulse from the vernal wood May teach you more of man . . .".

Mr. E. Earnest has done his work admirably well; but he might have told us a little—for he tells us nothing—about the many plants which the Bartrams discovered and sent to England.

D'ARCY W. THOMPSON.

CHEMISTRY IN WAR

Annual Reports on the Progress of Chemistry for 1940

Vol. 37. Pp. 525. (London: Chemical Society, 1941.) 15*s*.

THERE is a proneness to designate this as a physicists' war in contradistinction to that of 1914–18, which was widely called a chemists' war. Then Great Britain was short of trained men, knowledge and the manufacturing equipment to make many materials essential for the State and the people; broadly speaking, the same applies this time to physics, which has changed during the last decade from a largely theoretical to a definitely applied science.

Though less is heard of the chemist it does not mean that he is stagnant: in fact both science and industry took the lessons of the War of 1914–18 very much to heart, perhaps more so than any other section of the community. A steadily increasing stream of highly trained students—chemists and chemical engineers—flows from the universities, while the industry has become both highly organized through its trade association, conscious of the value of more and more research, up to date in its methods of manufacture. As a result the outbreak of war found it able to supply the national needs of essential chemicals and medicinals and to undertake without much delay the manufacture of a few substances protected by patent and hitherto imported.

It is common knowledge that there is now increased pressure for every single thing that can be produced at home, and even this greatly enhanced demand for chemicals has been largely met. Substitutes usually mean synthetic materials in which chemicals are involved, and now that the stage has been reached of making substitutes for substitutes it is more than ever a question of more chemicals. Thus the very fact that little if anything is heard in public of the chemical industry, of the shortage of this or that chemical, of the need for trained men, is a tribute to the prevision of the industry and to its pre-war organization. We write "pre-war" in order that we may repudiate the term as indicating preparation: the industry was organized to supply the nation and the export trade with an expanding need for each and every chemical at competitive prices in normal times of peace. It has no interest in war chemicals as such; in war it diverts explosives from the mines to the guns and has to make so much more of this and that taken away from their multitudinous ordinary everyday uses. Those who are pleased to rant about the prostitution of science to war sometimes speak in ignorance.

The individual chemists are likewise playing their part, and the research workers, now a great army, are for the most part engaged in solving the nation's problems. In spite of this the scientific journals still contain original papers and abstracts of work in other lands; there is more than enough to form the subject of annual reports even more crammed with undigested material than usual.

These reports were originally issued in 1905, when Sir William Tilden was president of the Chemical Society, to present an epitome of the principal definite steps in advance "in order that specialists in any one department of the science may obtain without difficulty information as to the nature and extent of progress in other branches of the subject to which they have not paid special attention".

Judged from this criterion, the individual reports are a disappointment. The older man, the industrialist, the specialist in one field, as we nearly all must be nowadays, will not find it easy from them to discover the state of knowledge in other fields. In fact, the reports are written by a specialist in a field for others in the same field, described in the notation or shorthand, sometimes termed jargon, used in that particular subject, and therefore as incomprehensible to outsiders as the shorthand notes of their secretaries.

Surely it is possible for our future chemists to write clear statements in English about a subject of which they are masters. The Chemical Society should say whether it has departed from its original intentions: as they are to-day the "Annual Reports" appeal to specialists only.

E. F. ARMSTRONG.

SCIENCE AND HUMAN NEEDS

AMONG the many subjects that were discussed at the Conference on Science and World Order held during September 26–28, there was none that met with more support and general agreement than the need for an increase in the standard of living, especially as regards nutrition. Gone are the days of 'subsistence standards', that would give the necessary number of calories to keep body and soul together.

The right of every individual to the means of attaining his full inherited capacity for health and physical fitness, said Sir John Orr, of the Rowett Research Institute, Aberdeen, should rank equal with his right to religious and political freedom. We have now an authoritative standard of dietary requirements for health, but when diets in common use are compared with this standard, it is found that, even in the wealthiest countries, the diet of the poorest third of the population does not come up to the standard. This rough estimate gives an indication of the extent to which mankind can be freed from much of the burden of disease, poor physique and resulting suffering which formerly was thought to be due mainly to heredity and, therefore, inevitable.

In the decade preceding the outbreak of the War, some Governments realized the importance of the new science of nutrition for human welfare and took measures to improve the diet of the poorest. These measures have had striking results. The great decrease in deficiency diseases, the reduction in both infant mortality and tuberculosis death-rate, the increased stature and better physique of school-children which have taken place in Great Britain in recent years, are due mainly to the great improvement in the diet of the poorest. This gratifying and rapid improvement in national health shows how easily average health and vigour can be raised.

If we are going to plan for human welfare, we should begin with a food policy based on nutritional needs. This would do more to promote health and happiness, and alleviate the worst effects of poverty, than any other measure. If every family knew that, in any circumstances, they would have sufficient of the right kind of food to give their children full opportunity for the enjoyment of a healthy life, the worst fear of want would be eliminated.

Mr. Herbert Morrison, the Home Secretary, while careful not to commit the Government, expressed himself in equally unequivocal terms. Within the last generation, he said, science has given us a new body of exact knowledge about human and social needs. Social scientists have told us that in Great Britain nearly half the population, a few years before the outbreak of war, had a diet below the minimum needed for health. The great experiment made possible by the War has demonstrated that a people living on a diet more restricted in bulk and variety, need not suffer in health—indeed may even show some improvement as measured by epidemic statistics—when steps are taken to ensure that the food they get contains the right proportions of those ingredients needed for healthy living.

Our satisfaction about national health during the War must not blind us to the fact that we are, partly through ignorance, partly through poverty, still well below an optimum food standard; health, growth and expectation of life will all be greatly improved if we can attain that standard.

Turning to the question of housing and town-planning, Mr. Morrison pointed out that systematic study of the effect on health of immediate environment, and analysis of housing standards, have indicated that a certain minimum individual allowance of space, privacy, fresh air and sunlight is an essential for health. Yet, judging by the Government standard of overcrowding, which is by no means strict, more than 340,000 houses in England and Wales are found wanting. In one of our great cities nearly a third of the population are living in a state of overcrowding. The death-rate in the slums of one city is 28 per thousand, as against 18 per thousand in municipal houses.

As to clothing, the Board of Trade has given a flying start to exploration of this field, by the system of rationing now in force. We can accept sixty-six coupons, and what they will procure, as a useful first approximation to a minimum—not, of course, an optimum—welfare standard in clothing.

Dr. Agnes Hamilton, of the London County Council, dealt with the needs of a specific group, the housewives. She expressed the hope that time-saving appliances and fittings, now found only in the more expensive modern dwellings in Great Britain, will become available to all. The chromium sink, the electric mixer, the refrigerator, Bakelite fittings, and central heating and hot-water arrangements, if made available normally for the woman in the home, could revolutionize her life and that of her family. Not only could the home-keeper dispose of her household chores in a time limited enough to permit her to follow a career, if she wants to do so, but work in the house would also become a skilled profession, such as can enlist the services of regular workers who have the talent

for it that does not belong to every woman as such.

An account of some of the recent social work carried out in the United States for the relief of malnutrition and improvement of health was given during the session on world planning by Prof. Alvin Hansen, professor of political economy in Harvard University and special economic adviser to the Federal Reserve Board. In 1934, he stated, surplus farm products were purchased by the Federal Government for distribution to needy families and for use in school lunch programmes. In 1939 the Food Stamp Plan was inaugurated. That plan is now reaching about four million families and distributing foods worth 120 million dollars a year. Most of the foods so distributed are protective foods needed by under-nourished families. Free lunches are now available to about four million school-children. Low-cost milk is being distributed in several large American cities.

The Conference on National Nutrition for Defense, held in Washington last May, recommended vigorous and continual research in nutritional problems, more widespread education of medical men, dentists, social service workers and teachers, in the newer knowledge of nutrition; also the mobilization of motion pictures, the radio, the Press, and home and community demonstrations to spread knowledge of nutrition among the people.

The programme of nutrition should be attacked from an international angle. Arrangements could be made for international exchange of surplus products to be used for free school lunches, since the means exist now, for the first time in history, to produce abundant food for all mankind.

The level of health in the United States to-day, Prof. Hansen said, is higher than ever before, but it is none the less true that large sections of the people do not share in the general high health-level, and it is only just beginning to be realized that to ensure available treatment to all is a basic public concern. In 1934 President Roosevelt appointed a Committee on Economic Security to study, among other things, the country's health needs, and after the passage of the Social Security Act in 1935, he appointed the Inter-departmental Committee to co-ordinate health and welfare activities. This Committee, in its report, envisages a gradually expanding programme, reaching its peak by the end of the tenth year. The programme includes the creation of public health organizations and facilities for combating special diseases, and for maternal and child health services; also the expansion of present hospital facilities and medical care for the medically needy.

Lord Hailey, in his address at the session on world planning, discussed the needs of the peoples of the British and other colonies. We must see that they have the type of nutrition that will establish the necessary measure of resistance to disease. They must have access to medical facilities for dealing with physical disorders, epidemics and other sickness; and access to such measure of popular instruction as will enable the mass of the people to adjust themselves to the needs of new economic and cultural conditions. It is only in the last few years that we have inaugurated a general survey of nutritional conditions in the Colonies, and the extent of popular education was for long dependent upon missionary initiative.

Several of the papers presented to the session on post-war relief also dealt with problems that are of a permanent nature. Prof. Julius Löwy, of the University of Prague, mentioned that delicate and convalescent children are in need of mountain and sea air, and that industrial workers suffering from systematic poisons must be placed in suitable climatic conditions. Dr. Anni Noll pointed out that regular periodic health overhauls of family units, such as are carried out at the Peckham Health Centre, London, are essential.

Mr. Noel-Baker, M.P., supported earlier pleas for a balanced diet: "We know how much protective and energy-producing food every child and adult ought to eat, in other words, we know what our food policy ought to be. We know with mathematical certainty that if we could give every one a minimum standard for maximum health, the community as a whole would be richer, healthier and happier in every way, and we know that if we plan right, we could produce the food. Mr. McDougall Inglis, who is a very high authority, says that we could do it for North America and Australasia in five years, for the whole of Europe in eight or ten years, and for the whole world rather longer."

Returning to Sir John Orr's address, which set the tone to many of the subsequent utterances, it may be pointed out that he referred to several diet standards: the British Medical Association's "minimum", the League of Nations' "optimum", the American Agricultural Department's "moderate" and the American National Nutrition Council's "lowest" standard. He might have added to these Cadbury's "suggested" diet and the Engineers' Study Group "desirable" standard. Sir John did not go into the differences between these standards—and perhaps it is unnecessary to do so at this stage. The following article dealing with post-war relief makes it sufficiently clear that the diet-level in Europe and elsewhere is already very low, and likely to be at a starvation-level at the end of the War. It will not be practicable therefore to begin with the highest level, and we shall have perforce to pass through the stages represented by the several 'balanced' dietary standards.

SCIENCE AND POST-WAR RELIEF

OUT of the present terrible conflict there will arise upon its termination widespread calls for succour and help, said Dr. Wellington Koo, the Chinese Ambassador, at the Conference on Science and World Order, in opening a discussion on post-war relief. The need of care for the sick, food for the hungry, nourishment for the young, housing for the homeless, prevention of epidemics, and many other forms of assistance will be pressing. All this requires planning, and science can do much to facilitate it.

An example of the work which will have to be done was given by Mr. R. Allen, of the American Red Cross, who has recently returned from relief work in France. He described how they had found hospitals in Occupied France completely denuded of all supplies, the Germans having taken over not only the buildings but also all medical materials, and left the French to set up hospitals in churches and schools. The American Red Cross was able to help them with medical supplies without interference from the German military authorities, and in Unoccupied France distributed milk to children under fourteen, with excellent results.

Mrs. H. Priestman-Breal, of the Friends' Relief Mission, who was engaged in relief work after the War of 1914–18, showed much human understanding in her analysis of the problems of relief and reconstruction. These, she said, offer a great opportunity for international friendship and understanding, but one that might easily be misused, even with the best of intentions. Skill and knowledge are needed in such matters, otherwise some of the results might be the very opposite of what is intended, because the people one means to help, though they might be better off materially, might nevertheless feel sore, humiliated and indignant, no matter how irrational such a feeling on their part might appear.

Mrs. Priestman-Breal gave an outline of some of the work done in Poland after the War of 1914–18. In her opinion, merely handing out relief seems unsatisfactory, as it encourages certain people to beg. She has found various schemes for encouraging the initiative of the people to be helped which gave good results : in spring and summer, ploughing columns and seed distribution were started, in autumn and winter, timber hauling for rebuilding houses was organized, and spinning, weaving and embroidery, in exchange for food rations, was encouraged.

A superior attitude on the part of the relief worker would be fatal. One must remember that while it is pleasant to give presents, it is sometimes less pleasant to receive them. In such countries as France and Germany the danger of giving offence would perhaps be greater, and any superior attitude might be even more resented.

Sir John Russell, of the Rothamsted Experimental Station, delivered one of the most vivid speeches of the Conference, in discussing the steps that will have to be taken towards "restoring the scorched earth". The Russian and Ukrainian peasants, he said, are following their traditional policy of burning their villages and destroying all crops and animals which they cannot remove to safety. The inevitable consequence is famine and pestilence, and large-scale relief will be necessary. Agricultural reconstruction will be, if anything, more important.

Fortunately, the destruction of the soil is not likely to be serious. The conditions in the Ukraine do not favour soil erosion such as occurred in the 'Dust Bowl' of the United States, in spite of the high proportion of cereal cropping—always a predisposing cause.

The reconstruction of agriculture will, however, be very difficult. Russian plant breeders have produced numerous varieties of crops specially suited to their different regions. Drought has always been a serious problem in the U.S.S.R. ; indeed the yields of grain are more dependent on favourable rain and snow fall than on any other factor. Rain- and snow-fall are out of human control, but in all countries the search for drought-resistant varieties is recognized as the surest way of coping with the problem. Russian men of science have been very successful in that field, and it would be a tragedy if the varieties produced as the result of so many years of labour should be lost. It would greatly facilitate reconstruction if selected varieties could be sent to western Canada and multiplied there in readiness for the time when the seed will be needed.

The reconstruction of the Soviet livestock population will be more difficult. It took five or six years to recover from the low level of 1933, which brought great distress to the U.S.S.R. Recovery would now be more rapid if the pedigree stock could be saved by sending animals eastwards out of harm's way. Selection and improvement have been steadily going on, and the technique of artificial insemination whereby a high-class male animal can fertilize a much larger number of females than is otherwise possible would be very helpful.

The destruction of trees is pathetic because it takes so long for them to grow again, but the British could help in regard to fruit trees, not by sending British varieties, which would not be at all

suitable, but by carrying on the Russian varieties, so as to ensure that the patient work of their fruit experts should not be lost. Very little material is needed, and it could be carried by air.

All these problems of reconstruction in the U.S.S.R., Sir John said, will arise in Poland also, but they will be intensified by the circumstances that Poland has no hinterland into which pedigree seeds or animals can be sent for safety, and the cutting down of the forests in the north will lead to soil destruction. We can greatly help agricultural reconstruction by maintaining British pedigree flocks and herds so as to supply breeding stock. After the War the planning of agriculture will become essential and special responsibility will devolve upon us as the largest buyers of agricultural produce. We must plan so as to safeguard British agriculture and to ensure that the distribution of British imports yields the maximum of benefit both to the producers of the materials and to ourselves.

Dr. E. Kodicek, formerly lecturer in psychology in the University of Prague, gave the warning that the organization of post-war relief will have to be based on a wide scheme of total post-war reconstruction rather than on charity. All attempts of the latter kind after the War of 1914–1918 were unable to deal adequately with the great tasks with which they were confronted, nor can they hope to do so after this War. To deal with these problems an efficient organization of scientific experts and politicians is needed which would have to possess sufficient executive powers to implement the plans upon which they decide.

There will be nutritional deficiencies in Europe in the west as well as in the east, and immediate measures will have to be taken to prevent a major disaster. But even more important is a constructive food policy for building up a post-war Europe. The relief programme will be the starting-point for mutual understanding and collaboration between nations. Plans for food distribution, food-growing, exchange, stocks of vitamin concentrates, care of mothers, children and the sick, and many other problems, will have to be organized from the wider outlook of nation-wide needs. The help of the separate Governments will be necessary, working in collaboration with each other and under an international organization.

The same considerations apply to health organization. Medical relief will have to be organized on the basis of State medical services, but will also have to pay regard to *inter*national as well as *intra*national requirements. Such services require to be directed by a central organization with executive powers. The immediate help needed after the War will include : medical supplies of all kinds, such as therapeutic sera and vitamin concentrates, the distribution and training of doctors to be sent to the distressed areas, etc.

As Mr. Hugh H. Smith, of the Rockefeller Health Foundation, pointed out, among the multiplicity of urgent problems which will face the post-war world that of health will be of prime and pressing importance. In no field will the 'good neighbour' policy be more necessary. Since no effective barrier can be raised against the entrance of many infectious diseases, each nation must concern itself with the health conditions of all other nations. Workers properly trained in the principles of epidemiology, supported by essential laboratory facilities, must be employed in the field. International effort must be co-ordinated and information must be collected by central agencies, for distribution to all.

Another urgent need of post-war reconstruction in the first days after the War, emphasized by Dr. Kodicek, is the planning of housing and the possibility of securing constructive work for the people. An international settlement of this kind would remove potential causes of discontent and unrest internally and internationally. The psychological re-education and enlightenment of people, who during the past few years have lost their faith in the pledged word, must be started now and intensified a hundredfold immediately after the War. Such re-education will be best helped by practical measures to be put into operation at the earliest moment. The simple force of the objects so achieved, together with the underlying idea of world understanding, repeated and again repeated by all methods of propaganda, would do much to persuade and convince people of the sincerity of Britain's aims.

The great opportunity offered by a concerted action in the matter of international post-war relief cannot be better expressed than in the words of Mr. Philip Noel-Baker, M.P., who recalled that President Roosevelt and Mr. Churchill have emphasized the need for building up a stock of food for post-war distribution. "The Allied Council has drawn up plans for the assembling, transport and distribution of such stocks. We know that Europe will be bankrupt, that this work will have to be done on lease-lend lines. It would be the greatest deed of charity in the history of mankind, ending the hunger of the people, saving scores of thousands of threatened lives.

"If the Government would treat relief as the first step in a long-term policy of world-wide scope, if they would hand it over to international control, if they would use that opportunity to replan for a new system, and mobilize behind it all the dynamic power of opinion that supports the Atlantic Charter, a new perspective of human welfare would indeed be opened up."

HUMAN LIFE AND DEATH AT HIGH PRESSURES

By PROF. J. B. S. HALDANE, F.R.S.

MEN are exposed to high pressures in a number of circumstances. They may be working in compressed air in a caisson or diving-bell, working under water in a diving dress, or attempting to escape from a sunken submarine. In the latter case it is obviously necessary that the air pressure inside a part of the ship should be equal to that of the water outside before a man emerges. This can be achieved either by flooding a small escape chamber holding only two men, or a whole compartment of the ship. Men have escaped by both these methods. They can rise through the water either holding their breath or breathing from a Davis submarine escape apparatus. The former method is not to be recommended, but it is not quite so hazardous as it sounds, for a lung-full of air at 5 atmospheres contains as much oxygen as a lung-full of oxygen at atmospheric pressure, and will allow a man to hold his breath for more than twice the normal time. The Davis submarine escape apparatus consists of a rubber bag and a soda-lime canister to absorb carbon dioxide. The bag is filled with oxygen from a small cylinder of the compressed gas. It has the advantage over air that it can be used almost to the last dreg. We shall come to its disadvantages later.

In June 1939, H.M. Submarine *Thetis* was sunk with civilians as well as naval officers and ratings. The Amalgamated Engineering Union and the Electrical Trades Union asked me to attend the investigation of this disaster, as some of their members had been killed. I was only able to carry out some very rough experiments during the course of this inquiry, but they made it clear that certain physiological factors concerned in escape from submarines had not been fully considered. I was therefore asked by Admiral Sir Martin Dunbar-Nasmith's physiological sub-committee on escape from submarines to undertake further research on this question, and it has very kindly permitted me to publish certain results. Messrs. Siebe Gorman and Co. put their plant and staff at my disposal. All the experiments described here were carried out in a small steel chamber at their works, which holds two, or at a pinch, three people in a sitting position. The experiments were conducted by Dr. E. M. Case and myself, on ourselves and twenty volunteers, including not only physiologists such as Dr. J. Negrin, the former Spanish Prime Minister, and Dr. B. M. Matthews, but also a number of working men. Four of our subjects were women. An account is in the press.

The physiological dangers fall under six different heads. The literature concerning (A) and (F), with a full discussion, has been given by Haldane and Priestley[1].

A. MECHANICAL EFFECTS

During rapid compression violent ear-ache, and even rupture of the tympanum, may occur if the pressure on the two sides of the tympanic membrane is not equalized. Most people can easily be taught to do this. Four working men who had never been in compressed air before were compressed to 10 atmospheres (corresponding to 300 ft. of sea water) in 5 minutes. A trained subject was compressed to 7 atmospheres in 90 seconds, and this rate could certainly be exceeded. About one subject in five cannot be taught to equalize the pressures rapidly.

During decompression there is less pain, but more danger to life. A number of men have died from rupture of the lungs, which forced air or oxygen into the pulmonary circulation, so that the circulation was blocked by air embolism. This was probably caused by a rapid rise of intra-pulmonary pressure, due to the subjects holding their breath while rising through the water. Any obstruction of the valve by which excess air leaves the escape apparatus would have the same effect. We have had no cases of embolism, but one of our subjects, Mr. J. M. Rendel, developed a pneumothorax.

At 10 atmospheres the density of the air is very striking. The voice becomes nasal, and the increased resistance of the air is obvious even when the hands are moved, and still more so when attempts are made to stir it. The resistance in breathing apparatus may be greatly increased, since the volume of air breathed is unchanged, but the mass increases tenfold, and turbulence may develop, increasing the resistance still further.

B. NITROGEN INTOXICATION

Behnke, Thomson and Motley (1935)[2] made the remarkable discovery that nitrogen is a narcotic at high pressures. We confirm their findings. In air at 10 atmospheres all our subjects felt very queer, and many behaved in an irresponsible manner. Manual dexterity was little affected, but arithmetical performance fell seriously in most cases. Some subjects became hilarious; others were greatly alarmed, and thought they were dying. Few could cope with several tasks at a time. There were, how-

ever, great individual variations. One subject, H. Spurway, though subjectively affected, was so resistant that her arithmetical performance was actually slightly improved at a pressure corresponding to 250 ft. The symptoms disappear when hydrogen or helium is substituted for nitrogen.

Behnke and Yarbrough (1939)[3] found that argon is rather more narcotic than nitrogen. These results are of importance for the general theory of narcosis, and further experiments with gases such as krypton, xenon and methane, which are regarded as physiologically indifferent, will be of great interest. It is also likely that at sufficiently high pressures, say, 20 atmospheres or more, hydrogen and helium will become narcotic. These gases would also perhaps reach the threshold concentration for taste or smell, as nitrogen and oxygen do for many people at a partial pressure of about 7 atmospheres.

C. Carbon Dioxide Intoxication

If a compartment of a submarine contained 1 per cent of carbon dioxide, this would not be noticed at atmospheric pressure. If, however, the compartment were flooded at 200 ft., the partial pressure would rise to 7 per cent of an atmosphere. This would make many people unconscious in less than five minutes, although fine work, such as gas analysis, is quite practicable in air containing 7 per cent of carbon dioxide at atmospheric pressure. The effects of carbon dioxide and nitrogen are additive. We investigated this question on a number of subjects. Their attitude may be exemplified by the notes made by Dr. H. Kalmus, a Czechoslovak refugee, just before losing consciousness at 10 atmospheres with a partial pressure of 6·5 per cent of carbon dioxide: "This is enough. This is enough.—Not necessarily too much." Consciousness was rapidly regained on decompression, and there were no appreciable after-effects.

D. Oxygen Intoxication

Paul Bert (1878)[4] found that oxygen is a convulsant at high pressures. At 7 atmospheres the convulsion comes on with little warning. There is a slight feeling of anxiety, which would, however, be disregarded under Service conditions. The clonic convulsions are very violent, and in my own case the injury caused by them to my back is still painful after a year. They last for about two minutes and are followed by flaccidity. I wake up into a state of extreme terror in which I may make futile attempts to escape from the steel chamber, whereas, like others, I am quite calm on recovery from carbon dioxide-nitrogen narcosis. Behnke, Johnson, Poppen and Motley (1935)[5] found that convulsions or syncope developed in men after about forty minutes at 4 atmospheres. We find that all of seven subjects could breathe oxygen for five minutes at 6 atmospheres. At 7 atmospheres, five minutes exposure is about the limit tolerated. It is obvious that convulsions of this sort would be fatal if they occurred while a man was wearing an escape apparatus under water.

E. After-effects of Carbon Dioxide

J. S. Haldane and J. L. Smith (1899)[6] reported vomiting on breathing ordinary air after breathing air containing a high percentage of carbon dioxide for some time. Alexander, Duff, Haldane, Ives, and Renton (1939)[7] reported vomiting and severe headache in several subjects after breathing air containing 6–7 per cent of carbon dioxide for an hour or longer. The same symptoms may occur if oxygen is breathed. We have not found such effects after breathing 6–7 per cent of carbon dioxide for so short a period as half-an-hour. Only one of the numerous subjects who lost consciousness when breathing air containing added carbon dioxide at 10 atmospheres even retched appreciably, and this was before losing consciousness, not on recovery.

It is clear that vomiting would be fatal during an attempted escape from a submarine, and it may have accounted for some of the deaths in the *Thetis*. It can be avoided by purifying the air, or by breathing oxygen or pure air for some minutes before attempting escape; this will give time for vomiting to occur if it is going to do so. On the other hand, this danger would not arise after a short exposure to a high partial pressure of carbon dioxide, such as is discussed under heading (C).

F. Bubble Formation during Decompression

This has been the principal physiological danger to divers in the past, and has been fully studied. The tissues take up nitrogen at high pressures. On decompression they become supersaturated and bubbles may form. With very rapid decompression, capillaries in the lungs and brain may be blocked with froth. This causes asphyxia and death unless the subject is at once recompressed. However, such embolism cannot occur if the blood has a reasonable opportunity of unloading its surplus nitrogen. The pressure should never be halved in less than a minute or so, which gives the blood from most organs an opportunity to release its nitrogen in the lungs. With slower rates the main symptoms are 'bends', that is to say, pain referred to the joints and bones, and other nervous symptoms such as paralysis and paræsthesia. These

are due to the formation of bubbles in the white matter of the central nervous system, and perhaps in the synovial fluid and bone marrow. Nitrogen is a good deal more soluble in lipoids than water, and this may account for the symptoms in question.

J. S. Haldane introduced stage decompression as a prophylactic, and Sir Robert Davis (1935)[8] found that this could be greatly accelerated if oxygen were breathed in the later stages. Even when oxygen is used, decompression lasts for an hour after 15 minutes exposure to 10 atmospheres. Unfortunately, no published figures exist on the limits of safety after very rapid compression to high pressures, followed by rapid decompression, such as occurs during escape from a submarine. We have obtained some data on this important problem. As regards decompression after longer exposures, some of our subjects have had slight symptoms when following the official tables, but these have never been serious. Others can be decompressed much more rapidly without any pain. We do not know the cause of this individual variation. Fatness may be a slight handicap, but I am fairly fat, and have had no trouble when following Sir Robert Davis's schedules of decompression, while thinner men have had 'bends' while doing so. Nor do we know the cause of the itching which is almost universal during decompression from high pressures, the rash which sometimes accompanies it, and the rarer symptom of nose bleeding.

Helium has been recommended as a preventive of decompression symptoms, and is used for this purpose in the United States. There is no question that it is of value at high pressures, as it completely does away with nitrogen intoxication. But I am much more doubtful of its value against 'bends'. Last December I was decompressed according to the Davis schedule after breathing a helium-oxygen mixture at 10 atmospheres. I developed severe pain over a good deal of my body which lasted for an hour or so, and which was followed by itching and 'pins and needles' over the area of the skin supplied by the 4th and 5th sacral roots. This was probably due to a bubble of helium in the conus, the tip of my spinal cord. Even after seven months I prefer a cushion to a hard chair, and may perhaps be excused for scepticism of the alleged prophylactic value of helium.

This failure of helium to prevent 'bends' throws a good deal of doubt on the current theories as to their causation. Helium is less soluble in water and fat than nitrogen; and whereas nitrogen is more soluble in fat than in water, helium is less so. For this reason it was erroneously concluded that it would be less likely than nitrogen to produce 'bends'. The whole problem demands a systematic experimental study with a number of gases. The experiments could be made on animals, whereas experiments on the narcotic effects of gases must be made on men. Animals give very unclear results in this case. Thus a canary flew normally in air at 10 atmospheres, while Drosophila refused to do so even when stimulated.

G. COLD

Even when the surface water is fairly warm, the sea may be below 40° F. at a depth of 200 ft. Among the questions which we investigated in this connexion was whether cold increases the narcotic effects of nitrogen and nitrogen + carbon dioxide. Dr. Case lay in a bath of melting ice until, after 12 minutes, he began to shiver violently. He was then compressed to 10 atmospheres, but retained his faculties sufficiently to multiply 47 by 13 in his head. I propounded this question, but was unable to solve it correctly, being more susceptible than he to nitrogen intoxication. A still more drastic experiment showed some adjuvent effect of cold, but it does not seem that any measures need be taken to combat it which would not be justifiable at ordinary pressures.

The main physiological problem to be tackled in planning escape from submarines at depths of 100 ft. or more is how to steer, so to say, between the Scylla of nitrogen poisoning and 'bends', and the Charybdis of oxygen poisoning. The detailed solution must depend on the details of construction of submarines and escape apparatus, so a full discussion is impossible at the present time. However, it also involves physiological investigations such as those here summarized, some of which will be published in greater detail elsewhere. I am convinced that physiologists have been far too negligent in investigating the limits of human existence, or at least of human consciousness. Physicists often find that mathematicians have already provided them with methods which they need for a theoretical account of their findings. It would be well if physiologists were to investigate the effect of abnormal conditions on human beings before, rather than after, these conditions have killed numerous people, whether in war or in industry.

[1] Haldane, J. B. S., and Priestley, J. G., "Respiration" (Oxford, 1935).

[2] Behnke, A. R., Thomson, R. M., and Motley, E. P., "Psychologic effects of breathing air at 4 atmospheres' pressure", *Amer. J. Physiol.*, **112**, 554 (1935).

[3] Behnke, A. R., and Yarbrough, O. D., "Respiratory resistance, oil-water solubility, and mental effects of argon, compared with helium and nitrogen", *Amer. J. Physiol.*, **126**, 409 (1939).

[4] Bert, Paul, "La Pression barométrique" (Paris, 1878).

[5] Behnke, A. R., Johnson, F. S., Poppen, J. R., and Motley, E. P., "The effect of oxygen on man at pressures from 1 to 4 atmospheres", *Amer. J. Physiol.*, **110**, 565 (1935).

[6] Haldane, J. S., and Smith, J. L., "Physiological effects of air vitiated by respiration", *J. Path. Bact.*, 1, 168 (1899).

[7] Alexander, W., Duff, P., Haldane, J.B.S., Ives, G., and Renton, D., "After-effects of exposure of men to carbon dioxide", *Lancet*, 419 (Aug. 19, 1939).

[8] Davis, R., "Deep diving and submarine operations" (London, 1935).

CENTENARY OF QUEEN'S UNIVERSITY, KINGSTON, CANADA

By Dr. R. C. Wallace
Principal and Vice-Chancellor

On October 16, 1841, a Royal Charter was granted to Queen's College, to be established in Kingston in Canada. The Presbyterian Church of Canada, resentful of the position which had been taken by the Anglicans in the management of higher education, felt that it was necessary to have a college at which men might be educated in arts and theology for the ministry of the Church, and made application for the charter. Thus Queen's began as a denominational college, and remained under denominational control until 1912, when the Presbyterian Church relinquished all connexion with the University. A Theological College then was established under separate administration, though closely connected with the University, and was associated with the Presbyterian Church until 1925, when, on the Union of Presbyterians, Methodists and Congregationalists in Canada, the Theological College became affiliated with the United Church of Canada, and still maintains that affiliation.

From the beginning the College took a liberal view of its responsibilities. It established teaching in the humanities, mathematics and theology, but almost immediately decided to embark on the teaching of medicine. The Faculty of Medicine was eventually established in 1856. Applied science came later, when the need developed for mining engineers and metallurgists to guide the growing mining industry in Canada. The School of Mines was set up in 1893, and when its activity had widened it was incorporated as a Faculty of Applied Science in 1916. Courses in commerce, banking and chartered accountancy, which had been carried on in association with the Faculty of Arts for several years, were organized under a School of Commerce in 1937.

These are the dry bones of detail of organization. They are not the things that are most in mind when one thinks of the hundred years which have passed over the head of the embryo Queen's College of 1841. Some of the more intangible elements of the story of Queen's University deserve mention, for they have much to do with the remarkable sense of loyalty and devotion which the graduates of Queen's show to their Alma Mater.

The most striking fact in the history of Queen's University is the constant struggle against difficulties, financial and otherwise, with which the institution was faced. Few universities are free from financial worries, but Queen's in her history has had more than her share. In time of difficulty students as well as staff took off their coats and worked, until the situation was relieved. Out of this sharing of hard times together there developed a sense of co-operate responsibility which has welded Queen's people into a solid community.

A second fact of importance in giving the University its own individuality has been the personality of the teachers. The older graduates, when they gather together, recall the days under the outstanding administration of George Munro Grant, when a galaxy of men, such as it has been the good fortune of few university heads to gather together, moulded the intellectual life and character of those who were fortunate enough to sit at their feet. Grant was a great Canadian statesman, who gave Queen's the status of a national university; and Watson, McNaughton, Jordan, Dupuis, Shortt and Cappon were names to conjure with. We like to feel that Queen's has not departed from the tradition. It is, *par excellence,* a teaching university.

Its service to teaching and to education found a special method of expression. Queen's instituted a system of extramural correspondence courses, by means of which students who could not take the winter terms at the University were able by correspondence work and summer sessions to complete the work for the degree, the condition being that more than half the work must be taken intramurally. This system, in which Queen's was the pioneer and is still the chief exponent, has been of very great service to the teaching profession throughout the Dominion. In normal years, in a student body of 4200, some 2400 are taking courses under the extra-mural system, and are sitting for the regular university examinations for the degree in arts, or the special examinations of the Institute of Chartered Accountants or the Canadian Bankers' Association.

The University has made a special contribution to the public services. Under the direction successively of Shortt, Skelton, Clark, Norman Rogers, McArthur and Mackintosh, all of whom have given distinguished service to the public administration, a long list of Queen's students have gone into the public life of Canada. Ottawa has leaned heavily on Queen's for men, and continues to do so; while in the provinces, and more particularly in

Ontario, the Civil Service has drawn in large measure from those who received their inspiration from the men who served Queen's on the teaching staff, and served their country later in significant administrative capacities.

Though the emphasis has been on teaching, Queen's has not failed in contribution to knowledge during these years. John Watson was for more than thirty years the exponent of speculative idealism on the American continent, and he exercised a very real influence on philosophical thought. Jordan and Scott led a school of liberal interpretation of theological dogma. Cappon, sparing in writing, was recognized to be one of our ablest Canadian literary critics. Shortt had proved himself to be an authority on banking and currency before he undertook to reorganize the Civil Service system at Ottawa. Skelton, in like manner, had become known for his researches in Canadian political history before he went to Ottawa to build up the Department of External Affairs. The economic studies of Mackintosh, and the studies in Canadian history of McArthur, Trotter and Graham, maintain for Queen's a high place in the social sciences.

In the physical and natural sciences, the University has gained a reputation in geology, for which Brock and Miller laid the foundation, now maintained by Bruce and his fellow-workers. The practical problems in the Canadian Northland, from the metallurgical point of view, have been faced by Kirkpatrick, who made an important contribution to the recovery and utilization of cobalt. Clark has done much work on the critical state of fluids, and Gray is well known for the contributions he and his co-workers have made to knowledge of atomic structure. One need only name the work of Humphrey in psychology, Vlastos in social ethics, Miller in pathology, Sinclair and Boyd in lipids, Reid in gas gangrene, Hebb in intelligence testing, McRae in organic synthesis, Ettinger in physiological reactions, to refer only to a few of the present-day workers, to show that in variety and—may I add—in quality of scientific research Queen's is playing its part.

Queen's celebrates its centenary by reviewing the progress of thought during the last hundred years. To that progress universities have made important contributions. In the development of knowledge during the next hundred years the universities will have an even greater part to play.

OBITUARIES

Dr. Walter Gardiner, F.R.S.

The name of Walter Gardiner, whose death occurred on August 31, will always be remembered by botanists and physiologists for his epoch-making histological researches and discoveries on the continuity of protoplasm. Owing to many years of ill-health, he was unknown to recent scientific workers, except by his classic papers.

Born on September 1, 1859, he died on the eve of his eighty-second birthday and was one of the veteran fellows of the Royal Society—only three now living having been elected before 1890, the year of his election, at the early age of thirty and a half years.

He was the younger son of Mr. Stephen T. Gardiner and was born at Burwell, on the edge of the Fens, between Cambridge and Newmarket. He was educated at Bedford and was a scholar of the Royal Agricultural Society during 1874–1876, and proceeded with a scholarship to Clare College, Cambridge. In 1881 Gardiner obtained first class honours in the Natural Sciences Tripos and took his B.A. degree in 1882 and M.A. in 1885, in which year he was elected to a fellowship at Clare College; afterwards he was made an honorary fellow of the College (1915). In 1883 he was appointed science lecturer at Girton College and the following year, University demonstrator in botany. This post he held until 1888 when he was promoted University lecturer. He resigned the lectureship in 1897. He was elected bursar of Clare College in 1895.

Gardiner was associated with the Cambridge Botany School during the last years of Prof. C. C. Babington's professorship, when botanical teaching and research was at a low ebb and was being conducted mainly on uninspiring descriptive lines. The appointment of S. H. Vines, however, as reader in botany in 1883 and his conjunction with Francis Darwin, opened a new era in Cambridge botany. Into this new atmosphere Gardiner threw himself with energy, giving remarkable lectures to the advanced students, building up the Museum—founded originally by Prof. J. S. Henslow—and carrying on his own histological researches, in which he was influenced and greatly encouraged by Michael Foster and by Thiselton-Dyer, then assistant director of Kew.

Botanical teaching in Great Britain being so unsatisfactory, as Prof. F. O. Bower has pointed out in his "Sixty Years of Botany in Britain", Gardiner, like several other young botanists, went to Germany and he worked in the Botanical Institute at Würzburg during the summer of 1882 under Prof. J. von Sachs, for whom he had a profound admiration. At

Würzburg he started his work on protoplasmic continuity, demonstrating its occurrence in the pulvini of *Mimosa pudica*. He was also able to prove the existence of connexions between the cells of the leaf of Dionea, between the parenchyma cells of the stamens of Berberis, and in many endosperm cells and in ordinary vegetable tissue. These results were given in several communications to the Royal Society, the Cambridge Philosophical Society, and the *Quarterly Journal of Microscopical Science* 1882 and 1883, and in the *Arb. a.d. Bot. Institut Würzburg*, Bd. III, in 1884. His best-known paper, with figures showing the connecting threads, is that in the *Philosophical Transactions of the Royal Society*, Part 3, 1883, pp. 817–63, with three plates. His earliest paper was on the development of the water glands in the leaf of *Saxifraga crustata*, illustrated by his own drawings (*Quart. J. Micro. Sci.*, 21, 417; 1881). Vegetable tannins, the constitution of the cell wall and middle lamella, and the mucilage-secreting cells of Blechnum and Osmunda (with Tokutaro Ito) (*Ann. Bot.*, 1, 1; 1887) were among the other subjects on which he published important papers. Protosplasmic continuity, however, was his dominant research, and he was indefatigable in attempting to perfect his methods and to demonstrate the existence of the fine protoplasmic connexions across the pit-closing membrane of all vegetable cells. Nothing but the best would satisfy him, and weeks might be spent—as the writer well remembers—before a result which he would pass could be obtained.

I was singularly fortunate in being asked by him in 1898 to work in his own laboratory, and here several happy years were spent with him in perfecting methods and demonstrating continuity between the cells of every plant subjected to investigation. Much of this work has never been published, but our joint papers on "The Histology of the Endosperm of *Tamus* during Germination" (*Proc. Camb. Philos. Soc.*, 11, Pt. 6; 1902) and on the connecting threads in *Pinus sylvestris* and other allied species (*Phil. Trans. Roy. Soc.*, 194; 1901) embody important aspects of his work.

Walter Gardiner was a remarkable lecturer and spared no pains fully to illustrate his lectures in an unusual and arresting manner. His afternoon lecture on "The Plant in the War of Nature" at the Royal Institution in 1888, and his evening lecture at the British Association meeting at Newcastle, 1889, on "Plants in the Struggle for Existence", were specially memorable.

Gardiner was awarded the Rolleston Prize by the University of Oxford in 1888, he and William Bateson being declared equal. In 1898 he received the Royal Medal from the Royal Society and in 1905 the degree of Sc.D. was conferred upon him by the University of Cambridge.

A keen naturalist, with a highly developed artistic sense, Gardiner had a very extensive knowledge of his subject, which was enhanced by his frequent visits to Kew, where he did much of his early work in the Jodrell Laboratory. Histological research in Great Britain suffered a great loss when he was incapacitated by illness from continuing his studies.

He married Miss I. W. Campbell, a great-niece of Sir Joseph Hooker, in 1893, to whom, and to their son, Mr. Alan Gardiner, F.L.S., and their daughter, we extend our sympathy. Arthur W. Hill.

Prof. Otfrid Foerster

Prof. Otfrid Foerster, one of the most prominent neurologists of the day, whose recent death has been announced, was born in Breslau on November 9, 1873. After receiving his medical education at Breslau, Kiel and Freiburg, he qualified in 1897. He studied under Prof. Dejerine at La Salpétrière, and then became assistant to Prof. Wernicke in the psychiatric clinic at Breslau, where he was appointed professor of neurology and psychiatry in 1921.

Foerster is perhaps best known for the operation to which his name is attached for the treatment of spastic paralysis and tabes, but his most important work consisted in his studies of the motor cortex and peripheral nerves. His principal publications were on the physiology and pathology of co-ordination (1902), co-ordinated movements in health and nervous and mental disease (1903), the essence of choreic motor disturbances (1904), contractures in pyramidal lesions (1906), diseases of the central and peripheral nerves (1923), hyper-ventilation in epilepsy (1925), and the paths of conduction of pain in flaccid and spastic paralysis (1927). He was, formerly, co-editor with Prof. O. Bumke of the "Handbuch der Neurologie" and on the editorial board of the *Deutsche Zeitschrift für Nervenheilkunde*.

Foerster was a good European and therefore no friend of the Nazis, which may account for his name not appearing in *Wer Ist's*, the German *Who's Who?* A eulogy of him, however, appears in the *Deutsche Zeitschrift für Neurologie* of 1933, on the occasion of his sixtieth birthday, by Prof. Max Nonne of Hamburg. He was well known in Great Britain, where, in 1927, he was elected an honorary member of the Section of Neurology of the Royal Society of Medicine, before which he delivered the ninth Hughlings Jackson Lecture in 1935, published in *Brain*, 59, 135 (1936), his subject being "The Motor Cortex in Man, in the Light of Hughlings Jackson's Doctrines". He was elected an honorary fellow of the Society in 1933. J. D. Rolleston.

We regret to announce the following deaths:

Baron Mataro Nagayo, formerly president of the Tokio Imperial University, director of the Japanese Foundation for Cancer Research, and editor of *Gann*, the Japanese journal of cancer research, on August 16, aged sixty-three years.

Prof. Rudolf Schoenheimer, associate professor of biochemistry in Columbia University, formerly head of the Department of Pathological Chemistry in the University of Freiburg, known for his work on the application of isotopes for the study of intermediary metabolism, on September 11, aged forty-three.

Mr. M. M. Ussishkin, president of the Jewish National Fund and chairman of the Zionist General Council, one of the founders of the Hebrew University, Jerusalem, on October 2, aged seventy-eight.

NEWS AND VIEWS

The Declaration of Scientific Principles

MR. H. STRAUSS, M.P., has written stating that the wording of Clause 4 of the Declaration of Scientific Principles presented at the British Association meeting on September 28 (see NATURE, Oct. 4, p. 393) is capable of misinterpretation. The British Association, through Prof. Allan Ferguson and Dr. O. J. R. Howarth, has acknowledged that it does not wish to prescribe any documentary statement as final, and that it is fully prepared to alter the wording of the Declaration in the light of friendly and constructive criticism, while leaving the spirit of the pronouncement unchanged. So far as science is concerned, the formulation of basic laws is undoubtedly profoundly influenced by the structure and state of the civilization in which the laws are formulated, but the shorthand statement, the so-called *law*, possesses neither sanctity nor finality. It is a policy rather than a creed. It is accordingly proposed to amend the wording of Clause 4 to read: "That the service of science requires independence combined with co-operation and its structure is influenced by the progressive needs of humanity."

International Youth Rally

AN impressive and stimulating International Youth Rally for Victory was held in London on September 11. A message from H.M. the King emphasized how clearly the young men and women of to-day appreciate the true meaning of the present struggle and the gravity of the task which the years of reconstruction will lay upon their shoulders. As Mr. Bevin, the Minister of Labour, pointed out, the Allied Governments are fortified in their present tremendous tasks by the support of the masses of the people, and are reinforced by the vision, enthusiasm and energy of the youth who are engaged on the battlefield, in the air, on the seas, in civil defence, in transport, in the workshop, and in the fields; to this might well be added the laboratory. "It will be yours to rebuild and shape the new world" said Mr. Bevin, so it is to be hoped that youth of the present and future will be given every opportunity to do so when that time comes.

That more than twenty nations took part is of more than casual significance. Youth are awake to their responsibilities, and are clearly anxious to give their all in the present struggle; they must be encouraged to give of their best in the long period of reconstruction which will follow the victory towards which they are now contributing the majority of practical effort. The very fact that such a rally was held was indicative of the desire of youth for new sources of inspiration and for genuine bases for co-operation between the youth of all nationalities in order to prepare them for their future responsibilities. The movement is deserving of every encouragement. Youth must be given greater chances, they must be given more sympathetic hearing, they must be represented to greater degree on all national and international counsels (including science) than they have in the past. Youth have often felt and sometimes expressed a feeling of frustration, a feeling of being overlooked or even overruled merely because of their youth. Such feelings must not be manifest in the youth of the future, if they are to play their just part in the world of to-morrow.

The Faraday Society and the U.S.S.R.

AT the annual meeting of the Faraday Society held on September 26, the following letter, signed by Prof. E. K. Rideal (president) and Mr. G. S. W. Marlow (secretary), to the Physical and Chemical Society of the U.S.S.R. was read and heartily approved by the members for dispatch: "At their first meeting after the invasion of Russia, the Council of the Faraday Society desires us on their behalf and on that of the Society to send greetings to our colleagues in the Union of Soviet Socialist Republics. Our two countries proudly stand allied as guardians of the freedom of the World against wanton aggression. By restoring such freedom to the temporarily enslaved peoples of Europe and Asia we shall enable the work of our men of science to bless mankind. The work of Russian men of science has assuredly shown to all the world what splendid results can be achieved. Russia's heroic resistance against the ruthless aggressor is a source of immense pride to her ally and will ever be remembered in history. We look forward with confidence to the day when the aggressor will be conquered and in the blessings of peace and freedom the members of our two Societies can meet in fraternal comradeship as allies in the peaceful quest of the laws of nature, just as now we are allies in the war on barbarian man."

Legislation on Town and Country Planning

IN the House of Lords on October 7, replying to a question from Viscount Samuel as to when the proposed legislation on town and country planning would be presented to Parliament, Lord Reith repudiated the suggestion that no progress has been made and that departmentalism is still obstructive. Lord Reith stated that the Council of Ministers has already produced a Bill which is in an advanced stage and excellent reports have already come from the interdepartmental committee associated with him on reconstruction problems. His statement, however, that as a result the Ministry of Health has appointed regional planning officers for all the regions to deal with problems that might arise and that the Minister of Works and Buildings is himself about to appoint regional authorities for propaganda purposes and to encourage local authorities to establish joint committees where they do not already

exist, was much less reassuring from the point of view of the central planning recommended in the Uthwatt report and endorsed from all quarters. Much is being done, however, said Lord Reith, with regard to the preparation of designs, and the supply of materials for post-war use, by standardization, economy of design and the use of alternative materials. He hopes to give an account of such activities and to make a more definite statement later, but assured the House that the need and urgency of the problem is realized and that the Government shares his view that the problems of peace are much more serious than the problems of war.

Chemical Society: New President

Dr. W. H. Mills, recently elected president of the Chemical Society, has for a long time been one of the outstanding figures in the scientific world: his influence on chemistry at Cambridge has been profound. An independent thinker, his researches bear no resemblance to those of his teachers: he founded a 'school', but he never had a 'team'. A paper by Mills is something to be read not only for instruction, but also for the intellectual pleasure it gives. His work on the cyanines, the photographic sensitizing dyes, was largely responsible for settling their chemistry, to which his former student, Dr. Hamer, has added so much. But it is for his stereochemical work that Mills is best known. In 1910 and 1914, with Miss Bain, he demonstrated the configuration of the doubly linked nitrogen atom, adding compelling evidence in 1923, with Schindler, and in 1931 with Saunders. The proof, with Warren, of the tetrahedral configuration of the ammonium ion compares for elegance with the proof, with Quibell and Lidstone, of the planar configuration of the 4-co-ordinated platinous and palladous atoms. The resolution of an allene, with Maitland, was also a remarkable achievement.

Mills's stereochemical investigations, in succession, of restricted rotation in naphthalene, quinoline and benzene derivatives, with Elliott, Breckenridge, Kelham and Dazeley are highly important. Reference must also be made to the 'Mills-Nixon' effect; to the mechanics of the Beckmann change; to a theory of absolute asymmetric synthesis; and to Mills's supreme skill with molecular models, by means of which he never fails to entrance an audience.

Dr. Dorothy Wrinch

Dr. Dorothy Wrinch has been appointed to a research professorship jointly by Smith, Mt. Holyoke and Amherst Colleges, in Massachusetts, to conduct a lecture and seminar course for advanced students on structure problems in the biological sciences. Dr. Wrinch is widely known for her exploratory work in mathematics, physics and biochemistry. During the past six years she has been working as a research fellow of the Rockefeller Foundation and has made an extensive study of the chemistry and physics of the proteins, the results of which have been published from time to time in Nature and in other scientific journals. Her research work on the structure of proteins, especially their two- and three-dimensional patterns, has attracted much attention. A distinctive feature of the new approach to the problem of protein structure which is employed by Dr. Wrinch is that it is based on the study of live proteins, while most previous structural studies have been conducted with dead proteins such as hair and silk, or with proteins which have lost their native configuration. Dr. Wrinch's views on the structure of globular proteins, based on the cyclol hypothesis, have provoked intense controversy, and while they are still by no means generally accepted, the discussion of their implications has provided a valuable demonstration of the interrelations of biology, chemistry, physics and mathematics.

Evaporation in the Sugar Industry

The first meeting of the session of the Newcomen Society was held on October 8. Two papers were read, the first by Messrs. N. Deerr and A. Brooks dealing with the "Development of Evaporation in the Sugar Industry", and the second by Mr. S. Withington on "Automobiles in 1830". There were three phases in the progress of the practice of evaporation, it was said, the first reaching back to the time when evaporation was conducted over a direct flame, the second phase being marked by the use of steam-heated appliances and the boiling of syrup under reduced pressure, while from this was developed the present practice of multiple-effect evaporation in a series of vessels. The review of Messrs. Deerr and Brooks ranged all over the world, and reference was made to many inventors, manufacturers and plants. One outstanding event was the patenting in 1813 by the Hon. Edward Charles Howard (1774–1816), a cadet of the ducal House of Norfolk, of the vacuum pan, a master patent appearing complete and successful in operation in its first trial. The first crude idea of multiple-effect evaporation was to be found in a patent of 1826. One of the chief improvers of the practice was Norbert Rillieux, who was born at New Orleans in 1806 and died in Paris in 1894. In 1934 persons connected with the sugar industry all over the world placed a tablet to Rillieux in the State Museum in New Orleans. Multiple-effect evaporation is to-day used not only in the sugar industry but also in others in which large quantities of liquids are dealt with.

Influence of War on Surgery

Mr. V. Zachary Cope gave a Chadwick Lecture on October 7 in which he discussed the influence of war on surgery. Surgery, or the handicraft of healing, he pointed out, has always been an art, but only recently a science. In pre-historic and historic times up to the time when Harvey discovered the circulation of the blood, surgery was a crude art, and for the most part surgeons learnt their lessons on the battle-field. When first there began to be an anatomical and physiological basis for surgery, it was upon the battle-field that trials of various discoveries were made. Antiseptics were given their first big trial in the Franco-Prussian war. Modern wars are upon

so large a scale that they provide unparalleled opportunities for the trial of new remedies, and the intensive research necessitated by the demands of war may concentrate within a year what would usually take ten years to do. The War of 1914–18 led to great advances in surgery. The prevention of tetanus by prophylactic administration of specific serum was standardized, and the treatment of shock and hæmorrhage by blood transfusion made readily available.

Moreover, the treatment of wounds underwent great changes during 1914–18. Antiseptics put into a wound were found to have little effect, and it was soon shown that the best results were obtained by excising the damaged parts of a wound. There is no doubt also that the same war was the chief means of putting thoracic surgery upon its present sound foundation. Even more striking was the rapid and wonderful development of plastic surgery whereby hideous deformities of the human face were remedied. In the recent Spanish Civil War, the main contribution to the advance of surgery was the discovery by Trueta that wounds treated by excision and encasement in plaster of Paris healed better than those which were treated by splinting and daily dressing. This was a useful application of the Winnett-Orr treatment and could be applied to simple wounds, to wounds of joints, and to open fractures. The present War has already provided some important contributions to surgery. The work of Colebrook on the local antiseptic action of the sulphonamide group of drugs, and the experimental results of Zuckerman's researches on the effect of blast, are noteworthy.

Vitamin B_1 in Buds of Trees

LARGE quantities of vitamin B_1 have been found in the buds and leaves of many common American trees by Prof. P. R. Burkholder and Prof. E. W. Sinnot. Using a constant-temperature tissue culture laboratory, they found heavy concentrations of the substance in the buds of oak, red maple, horse chestnut, elm, sycamore and white pine trees. Although vitamin B_1 is now produced by synthetic chemical processes, this discovery points to a large natural source of vitamin B_1, and this finding may offer a clue to the source of essential vitamins for many forest animals, according to Prof. Burkholder. The vitamin seems to be formed in the young leaves and growing points of the shoot, whence it is transported to the roots and various portions of the plant.

Experiments in which basswood and maple trees were ringed in the spring show that almost no vitamin B_1 has appeared below the ring in midsummer. Yet huge quantities of the vitamin have been found above the ring. This seems to indicate that ultimately a ringed tree may die not only from lack of food but also from vitamin starvation. These researches show that most green plants contain sufficient amounts of the vitamin for their normal growth. The amount of essential minerals in the soil and sunlight apparently influence the amount of B_1 which green plants are able to produce. Vitamin B_1 is heavily concentrated in the buds, according to Prof. Burkholder, just as it is in grain.

Health of Paraguay

IN the July issue of the *Boletín de la Oficina Sanitaria Panamericana,* Dr. Ricardo Odriosola, Minister of Health for Paraguay, states that organized public health work in his country began on August 16, 1889, with the creation of the National Health Council, which was merged in 1917–18 with the National Public Assistance and Welfare Commission (created in 1915) to form a Department of Health and Welfare. This was succeeded on June 15, 1936, by the present Ministry of Health, with its five departments—Public Health of the Capital, Rural Hygiene, Hygiene, Child Welfare and Odontology. Paraguay's most serious problems at present are surveys of the causes of death and the system of school lunches, to which 15 per cent of the municipal income has been assigned, and which are now being supplied in eighty towns. Leprosy comes next in importance. Compulsory vaccination against typhoid fever has been introduced. Malaria has become increasingly severe, and fourteen sanitary commissions have been organized to combat it by distributing quinine, oiling breeding-places of mosquitoes and draining swamps. Hookworm disease is also being combated.

Announcements

DR. A. EICHHORN, director of the Animal Diseases Station, Beltsville, Maryland, has recently visited Great Britain for consultations with the Ministry of Agriculture and Fisheries and the Agricultural Research Council. He has visited several institutes concerned with problems of animal health, and discussed with members of the staff the experience in Great Britain and in the United States in the control of various diseases of livestock. It is hoped that the liaison thus established between American and British veterinary scientists will be continued and extended.

THE following appointments have recently been made in the University of Sheffield: Miss A. R. Murray, assistant lecturer in chemistry; Mrs. Margaret G. Happey, assistant bacteriologist; Mr. H. I. C. Page, assistant demonstrator in radio physics.

THE following appointments and promotions have recently been made in the Colonial Service: D. J. Billes, agricultural superintendent, Gold Coast; P. L. Bradley, agricultural officer, Nigeria; H. M. Tickler, agricultural officer, Northern Rhodesia; M. S. Parry, assistant conservator of forests, Tanganyika; J. McCulloch, veterinary officer, Nigeria; G. C. Weatherhead, veterinary officer, Uganda; A. B. Killick (deputy director of agriculture, Tanganyika), deputy director of agriculture, Kenya; G. W. Lock (agricultural officer), senior agricultural officer, Tanganyika.

ERRATUM. In the letter entitled "Constitution of a Sulphonamide" in NATURE of October 4, p. 409, Mr. M. A. Phillips referred to "a tautomeric mixture of the forms II and III"; this should read "forms I and II".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.*

An X-Ray Criterion for Distinguishing between Lattice Curvature and Fragmentation

Asterism in Laue photographs and the arc-shaped smears in monochromatic X-ray photographs show that, in plastically deformed crystals, regions of different orientation are present. This may be due either to local curvatures of the lattice[1,2], or to its

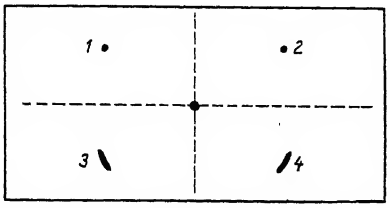

Fig. 1.

disintegration into a mosaic of small fragments the orientations of which are independent of those of their neighbours[3,4]. It has been considered that X-ray methods could only reveal the existence of regions of different orientation, but could not give information as to how these regions were joined

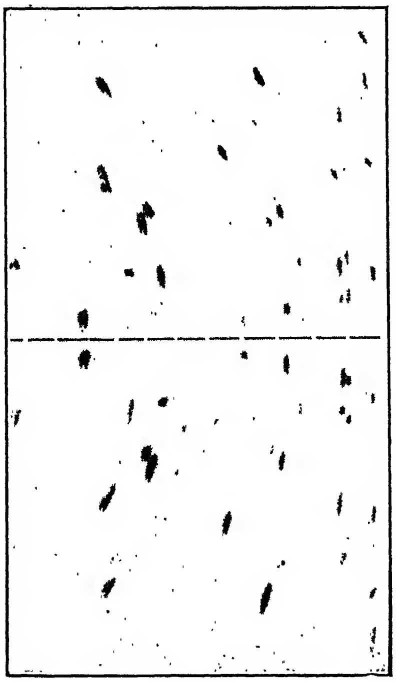

Fig. 2.

Part of a rotation photograph, enlarged 1·62 times. Cd crystal, about 1 mm. thick; extension about 2 per cent. The dotted line is the equator. CuK_α-radiation; camera radius 3·0 cm.

together, and thus could not tell which of the two alternatives, curvature or fragmentation, was present.

Rotation photographs of moderately extended cadium crystals have shown, however, that in many cases X-ray methods are capable of deciding this question. Such photographs often contain remarkably sharp spots (sometimes sharper than the spots obtained before distortion). Whenever a spot 1 (Fig. 1) is unusually sharp, the corresponding spot 2 on the same side of the equator (reflected by the same lattice plane) is equally sharp, but the two corresponding spots 3 and 4 (reflected by the other side of the same plane) are smeared out to arcs. Fig. 2 shows this effect on an enlarged portion of a rotation photograph.

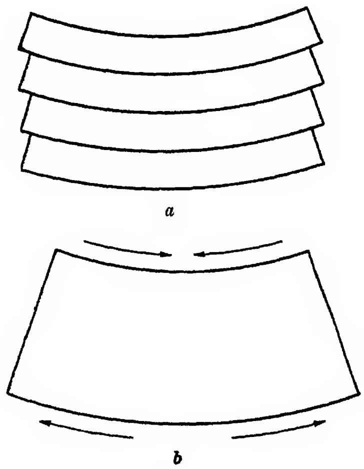

Fig. 3.

To explain the dissymmetry of corresponding spots above and below the equator, we have to assume that the lattice plane is curved and the beam emerging from the pin-hole is focused on the film as if it is reflected from the concave side of the plane; in this case a particularly sharp spot results. If, on the other hand, the beam falls upon the convex side of the plane, it is reflected with strong divergence, and a smear is produced.

The lattice planes from which the spots in Fig. 2 were reflected were plotted in a stereographic net, and the degree of dissymmetry between the reflexions from the two sides of the planes indicated by markings. The dissymmetry was a maximum for the basal plane (reflexions (0004) and (0006)) and for planes inclined at small angles to it (for example; (10$\bar{1}$6) and (10$\bar{1}$5)); with increasing angle it decreased, and became small and of rather irregular variation for planes approaching the zone of the hexagonal axis. Since the curvature of the glide plane in an extended single crystal is approximately cylindrical, with the cylinder axis perpendicular to the glide direction, it was to be expected that lattice planes perpendicular to this axis remained plane. It did not seem to make any difference, moreover, whether or not a plane was

nearly perpendicular to the cylinder axis; the dissymmetry of the reflexion diminished for all planes with increasing angular distance from the basal plane. This may be attributed to a disintegration of the bent crystal into glide lamellæ (Fig. 3*a*). Such a process is bound to occur, as otherwise bending would produce extremely high tensile stresses on the convex side, and extremely high compressive stresses on the concave side of a thick block (Fig. 3*b*). If the crystal consists of thin bent lamellæ, lattice planes perpendicular to these will show no dissymmetry of the X-ray reflexions, since initially plane sections perpendicular to the surface of a lamella remain approximately plane in elastic bending.

In the case of polycrystalline metals, the mutual interference of neighbouring grains will give rise to particularly sharp curvatures and thin lamellæ. The dissymmetry effect cannot be observed if the focal length of the curved lattice planes becomes too small compared with the radius of the X-ray camera, but the reflexions will show the diffusion and broadening (Scherrer effect) usually attributed to random fragmentation. With increasing deformation, the elastic energy of the bent lamellæ and their mutual surface energy become high enough for recrystallization to occur. This is strikingly illustrated by observations of Andrade and Chow[5], who found that the tails in Laue photographs of distorted iron crystals broke up into distinct spots at sufficiently high temperatures; with sodium and potassium, this process took place at room temperature, but continuous tails were observed at very low temperatures. All metals may recrystallize at room temperature if the distortion is severe enough. At a given temperature, therefore, local curvatures of the lattice and its splitting up into lamellæ, with the accompanying diffusion of X-ray reflexions, increase only up to a critical distortion at which recrystallization begins[6]. The existence of such a limit to the amount of diffusion has been observed by Gough and Wood[4].

E. OROWAN.
K. J. PASCOE.
Cavendish Laboratory,
Cambridge.
July 30.

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Photo-Electric Alloys of Alkali Metals

IN order to obtain very thin photo-electric layers, P. Görlich[1] investigated alloys of alkali metals with other metals and found that very thin layers of cæsium-antimony and cæsium-bismuth alloys are sensitive to visible light. I have made some further experiments with these alloys and obtained some results which are summarized below; a more detailed description will be published elsewhere.

The most sensitive alloys of cæsium and rubidium with bismuth and antimony correspond to the stoichiometric formulæ BiM_3 and SbM_3, M representing the alkali metal.

The alloy layer with the highest photo-electric quantum yield is $SbCs_3$. At the optimum wavelength of 4600A., one electron is emitted for only five incident light quanta.

The electric resistance of the antimony-cæsium alloy rises sharply with increasing Cs : Sb ratio. The specific resistance of pure antimony is 4×10^{-5}, the specific resistance of $SbCs_3$ is $1 \cdot 6 \times 10$. The alloys of lower photo-electric sensitivity have a lower specific resistance than $SbCs_3$. The rise of resistance during the formation of the photo-electric alloys is accompanied by the disappearance of metallic reflection. The alloys of the $SbCs_3$ type can therefore be regarded as semiconductors. They represent borderline cases between metallic alloys and ionic crystals, as is to be expected from the position of bismuth and antimony in the periodic system.

It has been impossible to obtain antimony-cæsium alloys in which the ratio of cæsium to antimony is greater than 3 : 1. The same is probably true for corresponding alloys.

Superficial oxidation of the alloys increases the photo-electric sensitivity to light of longer wavelengths. This effect can be explained by the lowered work function of the surface.

From theoretical considerations one would expect that a semiconductor with low surface work function, as represented by the $SbCs_3$ alloy, would be a good photo-electric emitter. But to explain the exceptional properties of the $SbCs_3$ alloy, as compared with the other alloys of the same type, the structure of these alloys would have to be investigated in more detail.

A. SOMMER.
Cinema Television, Ltd.,
London, S.E.26.
Feb. 11.

[1] Görlich, *Z. Phys.*, **101**, 335 (1936); *Z. tech. Phys.*, **18**, 460 (1937); *Phil. Mag.*, **25**, 256 (1938).

Influence of the Synthetic Œstrogen Triphenylethylene on the Growth and Egg-laying Capacity of Poultry

Robson and Schönberg[1] have shown that triphenylethylene, a synthetic substance which is easily prepared and now commercially obtainable, will induce œstrous changes in the genital organs and mating in ovariectomized mice and hypophysectomized rabbits. The effect in mice may last for several months. Robson[2] has reported on the induction of œstrous changes in the monkey and bitch by triphenylethylene. He stated also that no toxic changes were observed in these animals or in mice injected with large doses of triphenylethylene[3].

We have investigated the action of triphenylethylene on the growth of poultry and on their egg-laying capacity. The experimental part of this work was carried out by one of us (A. G.) at the Animal Nutrition Experimental Station, Faculty of Agriculture, Giza, Cairo. So far as could be ascertained, no experiments of this kind have hitherto been reported.

The average weight of a hen during the period September 1938–November 1939 was increased by 74·23 per cent after receiving 0·7 gm. triphenylethylene in comparison with 64·54 per cent increase of those not receiving triphenylethylene. The egg-laying capacities of hens are practically unaffected by triphenylethylene as regards either weight or number of eggs.

The average weight of the male turkey chicks was almost uninfluenced by triphenylethylene, in contrast to females, which increased their average weight by 311·5 per cent after receiving 2·73 gm. triphenylethylene a head. Female birds to which no triphenylethylene

was given increased their weight by 244·6 per cent only (compare table at end).

(1) *Experiments with white native (Baladi) hens.* Experiment *A T* was carried out on 25 hens. Triphenylethylene (0·5 gm.) was given with the morning ration for every ten hens three times a week, on Saturday, Tuesday and Thursday, during March 14–April 13, 1939 (0·7 gm. per hen per month). Experiment *B* was carried out on 26 hens to which no triphenylethylene was given. Feeding and age (4 months and 10 days at the beginning of the experiment) were the same for Groups *A T* and *B*. The results are given below.

	Group *AT*	Group *B*
Average weight of hen at the beginning of the experiment	939 gm.	939 gm.
Average weight of hen at the end of experiment . . .	1636 gm.	1545 gm.
Average increase in weight .	74·23 per cent.	64·54 per cent.
Total number of eggs laid per hen in 15 months (Sept. 38–Nov. 39)	115·08	123·67
Average number per month per hen	7·67	8·24
Average weight of an egg (Sept. 38–Nov. 39)	39·2 gm.	39·33 gm.

It seems, therefore, that triphenylethylene had little or no effect on the number or weight of eggs laid, as Group *B* was a little better than Group *A T* before, during and after the period during which triphenylethylene was given.

The ration for the white native hens consisted of: maize, 28; barley, 28; beans, 13; bran, 20; sesame cake, 8; fish powder, 1½; meat powder, 1½ per cent. In addition, we added for every 100 kilos, 1·5 kgm. fish powder (instead of bone powder, which was not available) and 0·5 kgm. sodium chloride.

The starch equivalent of the ration was 63·41 per cent, and the digestible protein 13·00 per cent. The daily ration was 90 gm. a hen. This quantity was given in two parts: (*a*) the mixture of bran, sesame cake, meat powder, fish powder and sodium chloride was given in the morning, slightly wetted; (*b*) the mixture of barley, maize and beans was given at noon. In addition to this daily ration, a hundred grams of barsim clover (*Trifolium Alexandrinum*) was given to each hen.

(2) *Experiments with turkeys.* The turkey chicks were put in four groups: *MT*, *FT*, *M* and *F*. In Group *MT* there were five males weighing 7·900 kgm.; in Group *FT*, eight females weighing 8·360 kgm.; in Group *M*, four males weighing 6·780 kgm.; and in Group *F*, eight females weighing 9·720 kgm.

Four equal quantities of the following mixture were prepared and put in different bins: maize, 29·5; barley, 29·5; beans, 12·0; bran, 20·0; sesame cake, 7·0; fish powder, 1·0; meat powder, 1·0 per cent. In addition to this, 1·5 kgm. shell powder and 0·5 kgm. sodium chloride were added.

The starch-equivalent of the ration was 67·82 and digestible protein 12·00 per cent.

Each bin was allotted to one of the groups of the chicks, and they were allowed to eat from this as much as they could every day by putting plenty of food before each group. The quantity of the ration consumed every fortnight was found by weighing that which remained in each bin.

3·8 gm. of triphenylethylene was added in the morning three times a week, on Saturday, Tuesday and Thursday, to the food of Group *MT* and Group *FT* during the whole experiment; no triphenylethylene was added to the food of Groups *M* and *F*. The total amount of triphenylethylene given to Groups *MT* and *FT* was 19·335 and 21·856 gm. respectively.

In addition to the above-mentioned food, barsim clover (*Trifolium Alexandrinum*) or green maize was also given to saturation. The quantities consumed daily were the difference in weight between what was put in front of each group in the morning and what remained in the afternoon. The total green diet consumed in every fortnight was recorded with the dry diet.

At the end of every fortnight, the chicks of every group were weighed to obtain the growth of each group.

These operations have been repeated during the whole of the experiment, which began on August 24, 1940, and ended on February 7, 1941. The summary of the experiments is tabulated as follows:

	Males		Females	
	Group *MT*	Group *M*	Group *FT*	Group *F*
Weight in kgm. on 24/8/40	7·900	6·780	8·360	9·720
Weight in kgm. on 7/2/41	38·450	31·970	34·400	33·500
Total growth . .	30·550	25·190	26·040	23·780
Percentage increase in weight	386·70	371·53	311·48	244·65
Food per kgm.—				
Grains and bran . .	176·805	161·428	232·860	230·348
Green maize . . .	140·910	118·212	203·028	191·932
Barsim clover . .	100·500	100·500	108·500	113·000
Total starch value during the experiment (kgm.) . . .	133·799	122·130	175·414	173·368
Kgm. starch value for every kgm. growth .	4·380	4·848	6·736	7·291

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[1] Robson and Schönberg, NATURE, 140, 196 (1937).
[2] Robson, *Proc. Soc. Exp. Biol.*, 38, 153 (1938).
[3] Lately more powerful derivatives of triphenylethylene have been discovered. Compare Schönberg, Robson, Tadros and Fahim, *J. Chem. Soc.*, 1327 (1940); and Robson, Schönberg and Fahim, NATURE, 142, 292 (1938).

Siderocytes in Man

SIDEROCYTES are erythrocytes in which the presence of some non-hæmoglobin iron can be demonstrated by the Prussian blue reaction[1]. They occur in the embryos and new-born young of normal rats and mice, and are greatly increased in numbers in the blood of mice suffering from the transitory anæmia associated with the gene for flexed-tail and belly-spot.

It has been suggested[2] that siderocytes in small numbers may occur in normal human babies at birth, but on account of their scarcity no definite decision was possible. Material has now come to hand which leaves no doubt that siderocytes are a normal embryonic feature in man, as in rodents. A 14-weeks-old fœtus (therapeutic abortion, heart-blood) had 94·3 per cent normocytes, 1·25 per cent normoblasts, and 4·45 per cent siderocytes ($n = 2{,}000$). Data on premature and full-term fœtuses are summarized in the accompanying table. The two 36-weeks-old

fœtuses are fraternal twins. The amount of siderotic material per siderocyte is generally small; in most cases a single granule is found, except in the earlier stages, where up to four granules per siderocyte are common. It seems safe to predict that a feature common to mouse, rat and man will be found to be widely spread among higher mammals.

Age in weeks of pregnancy	Sex	Siderocyte Percentage	Cells counted
33	♂	3·65	2,000
36	♀	1·15	2,000
36	♂	0·14	5,000
40	♀	0·10	2,000
40	♀	0·25	2,000

It is perhaps worth pointing out that in this case the study of an inherited disease of the mouse has led to the discovery of a normal embryonic feature of apparently wide distribution, including man.

I am greatly indebted to Dr. H. H. F. Barns, of University College Hospital, London, for the blood films on which this report is based.

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Pterygoquadrate Connexions in the Embryos of *Ichthyophis glutinosus* (Apoda)

THE pterygoquadrate in the embryos of *I. glutinosus* Linn. shows the ascendens and the otic processes; in the orbitotemporal region the basal process is not developed, and, therefore, the union of it with the basitrabecular process as seen in Siphonops (70-mm. larva, Edgeworth , Fig. 386) is absent. The relation of the processus ascendens with the orbital cartilage has been variously described. According to Edgeworth[1] and Winslow[2], a connexion is established in embryonic stages, while Peter[3], who examined a slightly older stage than that of Edgeworth, does not show it. Prof. E. S. Goodrich suggested to me (*in litt.*) that this difference may be due to the two authors examining two different species of Ichthyophis, but this may not be so, for both secured their material from Dr. F. Sarasin. In my sections of a 30-mm. embryo of *I. glutinosus* at any rate the ascendens connexion is not present, thus resembling Hypogeophis.

On the other hand, the uniform occurrence of the otic connexion in Ichthyophis (the processus oticus of the pterygoquadrate uniting with the stapedial process of the stapes) is noteworthy, though Edgeworth[1] and Goodrich[4] quoted to the contrary. This connexion is noticed in all the embryos examined by me, and in the adult it becomes a joint. In Hypogeophis also Marcus, Stimmelmayr and Porsch[5] described a transient otic connexion. But according to de Beer[6], the definite chondrocranium in Ichthyophis with no connexions of the pterygoquadrate with the cranium conforms to the primitive autodiastylic type, whereas in Hypogeophis, with the temporary otic connexion, the larval cranium is 'amphistylic'. As an otic connexion was also noticed by me in all the embryos of *I. glutinosus* examined[7], the chondrocranium does not conform to the autodiastylic type.

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A New Antibacterial Agent produced by a Mould

IT has been shown in this department that penicillin, a substance produced by the Penicillium discovered by Fleming[1], has very remarkable chemotherapeutic properties[2]. Consequently, it became of interest to see whether other species of moulds produced substances with similar properties. Of a considerable number of air-borne moulds studied, two were found to produce substances very similar to penicillin, both in its chemical and biological behaviour. Recently, however, a mould, probably belonging to the genus Aspergillus, was found to produce a powerful antibacterial agent with chemical properties different from penicillin and with an antibacterial range considerably greater than that of penicillin. In addition to the Gram-positive organisms known to be inhibited by penicillin, the growth of a number of Gram-negative organisms, such as *Bact. coli*, *B. dysenteriæ* (Shiga), the typhoid and paratyphoid bacilli and *Vibrio choleræ*, is inhibited by the culture filtrate, of this mould. An extract of this new antibacterial substance has been prepared from the culture filtrate, and it was found that it inhibited the growth of both the Gram-negative and Gram-positive organisms in a dilution of approximately 1 : 200,000. It remains to be seen whether this substance bears any relation to the bactericidal agent in culture filtrates of *Aspergillus flavus*, described by E. C. White[3].

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Rotifer vulgaris and Tetanus Toxin

DURING an estimation of anti-tetanic serum, 0·02 c.c. of a filtrate of a meat broth culture of *Clostridium tetani*, 0·01 c.c. of which filtrate, injected intraperitoneally, had previously killed a mouse in eighteen hours, was slowly added to 0·03 c.c. of water from a rain-gutter

containing five *Rotifer vulgaris*. All the rotifers were dead at the end of four minutes. In one specimen observed, addition of 0·01 c.c. of the filtrate caused retraction of the ciliary wreath, and some slowing of bodily movement, though the jaws remained active. Addition of the remainder caused the jaws to slow, and the body gradually contracted, without convulsions, into a double mass with a central constriction. The other four rotifers presented the same post-mortem appearance. Small monads also present in the water showed no diminution of activity after fifteen minutes.

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Epidermal Papillæ and Dermal Bones of the Chick Sclerotic

THE article in NATURE by Moy-Thomas[1] and Westoll's comments[2] discuss the interesting relation existing, in fish, between certain structures of ectodermal origin and certain dermal bones. It seems appropriate to report briefly upon a similar relation which I have recently studied in the embryonic chick. A more complete account will be published elsewhere. It is well known that the fowl has fourteen dermal bones in its sclerotic, forming a ring round the pupil, and that the same number of epidermal papillæ develop in the conjunctiva at about seven days of incubation but disappear before hatching. Nussbaum[3] and Dabelow[4] both studied the papillæ, but as their descriptions are in several respects unsatisfactory, I have examined these structures, and especially their relation to the dermal bones, afresh.

The papillæ first appear as flat thickenings of the epidermis. Later, on the eighth and ninth days, the central part of each thickening increases greatly and projects downwards as a conical mass of epithelial cells into the underlying mesenchyme, against which it is bounded by a basement membrane. I call this downward projection the 'tongue'. The papilla also projects slightly above the general epidermal level. There is a condensation of mesenchyme cells below and around the tongue; these cells are the *Anlage* of the future scleral bone. Careful study shows, in sections stained with azan, that very delicate blue-staining collagen fibres run off from the basement membrane of the papilla, and especially from its tongue, among these mesenchyme cells. Even while it is forming, degeneration sets in among the epithelial cells at the base of the tongue and in its substance. This continues during the ninth and tenth days, and the result is the liquefaction of the greater part of the cells forming the tongue, which gradually retracts and finally disappears. At the same time the elevation of the papilla above the general level of the epidermal surface increases and the papilla is transformed from a solid mass projecting principally downward into the mesenchyme, into a hollow, more or less filiform structure, projecting upwards from the epidermis and joined to it by a rather narrow neck. Its cavity is open to the mesenchyme below, and contains mesenchyme cells.

Meanwhile, the cells of the mesenchyme condensation, originally grouped round the 'tongue', stream from this position downwards and outwards, and become arranged as a flat sheet of cells below the papilla and separated from it by mesenchyme which at last shows little or no condensation. The first collagen fibrils of the developing bone are now deposited among these cells, which take the histological character of osteoblasts. A connexion with the papilla is, however, maintained. The delicate collagen fibrils, mentioned above as running from the papilla among the mesenchyme cells around the tongue, have increased in number and thickness, and when the histological differentiation of the bone is beginning they form a very obvious strand of fibres running from the cavity of the hollow papilla, down through the intervening unspecialized mesenchyme, to the bone, with the developing collagen fibrils of which they are continuous.

The papillæ disappear completely before hatching, and it is difficult to imagine what function they can serve if it is not concerned with the development of the scleral bones with which they are so closely connected. Experimentation must wait until eggs once again become available for purposes other than food; but it will be as surprising as Moy-Thomas's results if the relationship proves to be without morphogenic significance.

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Poultry as Food Converters

THE article by Mr. E. T. Halnan in NATURE of September 20 threw an interesting light on the problem of achieving the maximum efficiency in livestock farming from the point of view of war-time food production. He made out a good case for giving prior right to the hen in the distribution of available feeding-stuffs, over meat-producing animals. The milk-cow easily takes first place as an efficient food converter, and its performance is still more amazing when one considers that, besides utilizing concentrated feeding-stuffs such as hens and pigs need, it also utilizes cheap, home-produced foods such as grass, hay, straw, etc.

This question of the kind of material an animal can utilize is, of course, practically as important as the efficiency of conversion. Grass is by far the cheapest and most plentiful feeding-stuff in Great Britain. There is one egg-producing animal which can utilize grass, namely, the goose. Would it not therefore be worth while making an effort to increase its efficiency as an egg-producer by systematic trap-nesting and selection, as has been done in the case of the hen and the duck? It did not take a very long period of systematic selection to increase the egg-production of ducks from a few dozen a year to the level of that of the most high-yielding hens, and the same thing would probably prove true of geese. At the same time, a smaller strain, producing an egg of a smaller, more convenient size, could be evolved by selection.

If, by these methods, geese could be made to replace hens largely as egg-producers in Britain, I think it would be an achievement of very great national importance.

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STANDARDIZATION OF VITAMIN E

If war had not broken out, it was intended by the Health Organisation of the League of Nations to hold a third meeting of the International Conference on Vitamin Standardisation, in preparation for which the Vitamin E Sub-Committee of the Accessory Food Factors Committee (Lister Institute and Medical Research Council), at the request of the Health Organisation, set on foot a co-operative study of *dl*-α- tocopheryl acetate as a possible international standard for vitamin E. It has in the interval been decided that it would be more accurate to use the name synthetic racemic tocopheryl acetate, and this will be done in future.

A supply of the substance sufficient for extensive biological and stability tests, and to provide a standard should the substance ultimately be adopted, was very kindly provided by Messrs. Hoffmann-La Roche of Basle, through the British associated company, Messrs. Roche Products, Ltd., Welwyn Garden City.

Workers in Europe and the United States experienced in vitamin E tests were invited to participate, and solutions were prepared by Dr. P. Hartley and issued to seventeen laboratories. The workers were asked to test four solutions of the tocopheryl acetate of graded strengths, the proportion in which the series was graded being stated, but no indication being given of the identities of the numbered solutions corresponding with the different strengths.

The object of the test was to obtain the relation between dosage and response, the response used being the fertility-rate defined as the percentage of positively mated female rats which produced a litter. Vitamin E deficiency is a condition which in an individual animal is not cured in a smoothly graduated series of stages ; for statistical purposes the response is treated as of an all or none, not of a graded, type. However, the dosage response relation can, as is usual in such cases, be transferred into a linear one by plotting the normal equivalent deviation (or probit) of the percentage response against the logarithm of the dose.

Arrangements were made whereby the stability of the feeding solutions after the tests and of the original material after keeping was tested spectrophotometrically by Dr. R. A. Morton, who reported that the stability of all the materials was entirely satisfactory.

Thirteen of the seventeen laboratories invited completed the biological tests and sent in reports which were submitted to Dr. J. O. Irwin and Dr. E. J. Williams, then at Cambridge, for statistical analysis. In four of the laboratories the slope of the dosage-response curve proved not to differ significantly from zero ; in other words the responses to the graded doses were not themselves significantly graded. No determination of the median fertility dose could therefore be made, and the results did not lend themselves to further statistical analysis. For the remaining nine laboratories such a study could be made and the results are summarized in the accompanying table.

Laboratory	No. of rats used	Slope of probit/log dose line	Standard error of slope	Median fertility dose (mgm.)	Limits of error	
					95%	99%
1	83	5·17	1·09	0·56	86–117	82–122
2 (*a*)	40	5·34	1·42	0·55	82–123	77–131
(*b*)	42	7·00	1·73	0·66	85–118	80–125
3	91	3·60	0·99	0·66	72–139	65–155
4	68	2·63	0·96	0·72	58–172	49–204
5	48	9·23	3·35	0·84	85–117	81–123
6 (*a*)	79	6·83	1·32	1·13	88–114	85–118
(*b*)	50	5·07	1·30	1·14	82–123	77–131
7	78	5·52	1·03	1·36	87–116	83–121
8 (*a*)	52	5·89	1·48	1·50	85–117	81–123
(*b*)	52	11·55	3·17	1·05	90–112	86–116
9	58	6·53	1·62	1·71	84–119	80–125
Means and errors Total	689	4·989	0·383	0·986	78–128*	72–139*

2 (*a*) and (*b*). Ratio of 4 doses the same in each case, but bigger absolute dose given in 2 (*b*).

6 (*a*) and (*b*) Virgins used in 6 (*a*) ; rats which had resorbed in 6 (*b*).

8 (*a*) and (*b*) Criterion in 8 (*a*) birth of at least one living young one ; criterion in 8 (*b*) birth of at least one young one, living or dead. Rats used in 8 (*a*) same as in 8 (*b*).

* This error includes error due to inter-laboratory difference.

The table shows the number of rats used by each worker, the slope of the probit/log. dose line, the median fertility dose and the limits of error for each worker's result. The median fertility dose is that dose which enables 50 per cent of the rats used to bear a litter. The results have been arranged in the table to show the variation in size of the median fertility dose, from 0·56 mgm. synthetic racemic tocopheryl acetate in the first laboratory, to 1·71 mgm. in the last laboratory, the average value being almost exactly one milligram. The reasons for the variation will be discussed when a fuller report is made, but it is interesting to note that the size of the median fertility dose varied in laboratory 2 in two separate tests, and in laboratory 8 when the definition of a litter was varied so as to require the inclusion of at least one living young one in the litter. These observations of the great variation in the size of the median fertility dose add further evidence, if that were needed, of the necessity for establishing an international standard for vitamin E so long as biological tests are needed.

The accuracy of the biological technique, as evidenced by the limits of error, seems to be about the same as that usually found with vitamins for a biological method which has been fully elaborated and in use for some time, and the whole co-operative study affords a satisfactory basis for recommending that synthetic racemic tocopheryl acetate should be adopted as international standard for vitamin E.

The workers who took part were: A. L. Bacharach, Glaxo Laboratories, Greenford, Middlesex ; A. Z. Baker and M. D. Wright, Vitamins Ltd., Hammersmith, London, W.6 ; F. Bergel, Roche Products Ltd., Welwyn Garden City, Herts. ; A. M. Copping Lister Institute, London, S.W.1 ; K. H. Coward and B. G. E. Morgan, Pharmaceutical Society, 17

Bloomsbury Square, London, W.C.1; V. Demole and H. M. Wüest, F. Hoffmann-La Roche and Co., Basle; H. von Euler, Biokemiska Institutet, Stockholm 6, Sweden; H. M. Evans, University of California, Berkeley, California; P. Hartley, National Institute for Medical Research, Hampstead, London, N.W.3; J. O. Irwin, Queens' College, Cambridge; B. C. P. Jansen, University of Amsterdam, Laboratory of Physiological Chemistry, Jon. Dan. Meijerplein 3, Amsterdam, Holland; C. Kennedy and L. S. Palmer, University of Minnesota, Department of Agriculture, University Farm, St. Paul, Minn.; K. E. Mason and W. L. Bryan, Department of Anatomy, Vanderbilt University School of Medicine, Nashville, Tenn.; H. A. Mattill, Department of Chemistry, State University of Iowa, Iowa City; T. Moore, Dunn Nutritional Laboratory, Milton Road, Cambridge; R. A. Morton, Department of Physical and Inorganic Chemistry, The University, Liverpool; A. R. Todd, Department of Chemistry, The University, Manchester, 13; S. W. F. Underhill, British Drug Houses Ltd., Graham Street, City Road, London, N.1; E. J. Williams, Forest Products Research Laboratory, Melbourne, Victoria.

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AN INTERNATIONAL STANDARD FOR VITAMIN E

It is now announced that an international standard for vitamin E has been established and that, as in the case of the international standards for the vitamins A, B_1, C and D, the National Institute for Medical Research, Hampstead, London, N.W.3, acting on behalf of the Health Organization of the League of Nations, has undertaken its supply to laboratories, institutes and research workers, throughout the world.

Synthetic racemic α-tocopheryl acetate ($C_{31}H_{52}O_3$) has been adopted as the international standard for vitamin E. The investigation of the chemical, physical and biological properties of this substance, its suitability for adoption as the international standard, and the manner of its application in biological assay was carried out, at the request of the Health Organisation of the League of Nations, by the Vitamin E Sub-Committee of the Accessory Food Factors Committee of the Lister Institute and the Medical Research Council. The sub-Committee was able to enlist the co-operation of experts in laboratories in Europe and the United States, and, as a result, it was able to recommend the adoption of synthetic racemic α-tocopheryl acetate as the international standard for vitamin E. The Sub-Committee further recommended that the international unit for vitamin E should be defined as the specific activity of 1 mgm. of the standard preparation, this quantity being the average amount which, when administered orally, prevents resorption-gestation in rats deprived of vitamin E.

In normal circumstances the results of the co-operative investigation would have been submitted for discussion at the Third International Conference on Vitamin Standardisation, which had been arranged for the autumn of 1939. On account of the War this Conference could not be held. The report and recommendations of the Sub-Committee have, however, been placed before those members and officers of the League of Nations' Permanent Commission on Biological Standardisation and of the International Conference on Vitamin Standardisation, who were available and accessible, and these consented to accept the responsibility of taking such decisions as would normally be accepted by a properly constituted International Conference and by the Permanent Commission. They have accordingly adopted the proposed standard for vitamin E, accepted the recommendation defining the international unit, and authorized the National Institute for Medical Research, Hampstead, to proceed with the distribution of the standard.

The international standard for vitamin E is issued in the form of a solution in olive oil of which one international unit is contained in 0·1 gm. It will be supplied to directors of national control centres in those countries in which these have been established, for local distribution; also to laboratories, institutes and research workers in Great Britain, and in those countries in which national control centres have not yet been established. Application should be made to the Department of Biological Standards, National Institute for Medical Research, Hampstead, London, N.W.3.

PSYCHOLOGICAL HANDICAPS IN THE SEARCH FOR TRUTH

BY DR. J. HETTINGER

THERE are three main psychological factors which handicap the mind in its search for truth, irrespective of the nature of the subject. They are:

(1) The limitations of the field of mental vision;

(2) Our personal mental worlds; and

(3) Our lack of knowledge of the true relationships between *all* existing realities and, accordingly, lack of unity in our personal mental worlds in correspondence with the unity reigning in the universe.

(1) LIMITATIONS OF THE FIELD OF MENTAL VISION

All forms of sensory perception have their respective limits, for example, as regards space, time, clearness, intensity, etc.; purely intellectual perception, such as we experience in mental contemplation and meditation, and which may be referred to as 'mental vision', extends over a field which has its own specific limits.

The first limitation of the field of mental vision is determined by the amount of knowledge we have

individually stored mentally by personal experience, observation and learning, out of the total knowledge acquired by the human race. We can scarcely imagine anyone possessing that total knowledge; and the latter is most likely still infinitesimally small as compared with the knowledge yet capable of acquisition in the course of the future history of mankind. Let us assume that there are some erudites who have followed the precept that "Everyone ought to know everything about something and something about everything". In these, presumably ideal, instances, the limitations are implied in the precept itself. It will thus be readily conceded, that in any controversial discussion, especially when a number of inter-related subjects are concerned, the fields of mental vision of the different participants will most likely vary to a great extent as regards the knowledge they respectively possess on the subjects which come into question; and in any event be limited as compared with the sum total of the knowledge at present available to the human race plus that which is still capable of acquisition.

The second limitation is imposed by the extent to and the rapidity with which knowledge stored as memory can be summoned from the subconscious into the conscious in order that it may be contemplated and meditated upon. The failure of any knowledge pertinent to a particular subject or set of subjects of emerging into the field of mental vision results in a limitation which may lead to wrong conclusions in the search for truth. Even if none failed to appear, unless the parts of pertinent knowledge emerged simultaneously or in sufficiently quick succession to enable the mind to contemplate them in their entirety, the conclusions may again be wrong.

A third limitation is that the field of mental vision often lacks clearness and stability, mainly due to uncertainty as to the accuracy of the knowledge displayed therein. This limitation is a great handicap in the perception of new from old knowledge according to the noegenetic principles of cognition enunciated by Spearman[1].

(2) OUR PERSONAL MENTAL WORLDS

This concept stands for the whole of the contents of individual minds, including all the factors, namely, thoughts, feelings and actions, responsible for their having been absorbed or built up therein. According to how our respective minds have gradually grown, altered, been acted upon, and reacted, they attain a characteristic state of their own, and they become more or less crystallized into a pattern which determines our mental attitude and behaviour.

We need not go into details to show by way of example how our personal mental worlds are gradually built up differently from early infancy, through the imitative and destructive periods, through the years of elementary and secondary school education, and so on, often in a haphazard way. Nor need we refer to the different inherited abilities and predispositions, emphasize the importance played by environment, dwell on the question of desires and ambitions, or point to the many present-day glaring examples indicative of the petrifying effect on our personal mental worlds exerted by all kinds of vested interests and by fear. The influence of all these factors on our psychological make-up is too well known.

In fact, we are now passing through a period of history which is a striking example of how the mental worlds of individuals may be so formed and transformed, that, although we are all living in one and the same world, facing one and the same reality, the mental worlds of some of us are poles apart from, and in conflict with, one another; and between these two extremes there are endless variations of personal worlds which conflict with one another in some respect or other.

We find that not only are the personal worlds of, for example, many representatives of religion totally different from those of many men of science, of many alleged to belong to the so-called 'capitalist class' equally quite different from those of many stated to be of the 'working class', of many nationals of one country opposite to those of nationals of another country, but also that within one and the same group the personal worlds of many are in conflict with one another, even as regards the facts supposed to constitute the very foundations of the group. Most of these are firmly convinced that they are right; but obviously it is a logical impossibility for all of them to be right if the views are mutually exclusive.

The fact that these conflicts are attributable to different patterns of individual mental worlds, and the pattern differences to the ways and circumstances in which those worlds were formed, shows the theoretical and practical value of the concept we have just discussed, as regards the study of psychological factors which handicap us in the search for truth.

(3) LACK OF KNOWLEDGE OF THE TRUE RELATIONSHIPS BETWEEN ALL REALITIES

It has already been pointed out above that the human race is far from possessing all the knowledge that it can, or may possibly, acquire. This applies also to the true relationships between *all* existing realities, including intangible ones, such as the relation between body and mind, natural phenomena and reasoning, gregarious instinct and moral behaviour, etc. Whether we shall ever be able to determine all of them may be left an open question. It is clear, however, that unless we know the actual relationships between *all* realities, including the mind, we cannot perceive the unity reigning in the universe and, consequently, assemble the total knowledge of our personal world in a corresponding unitary system. This means, however, that so long as our knowledge is wanting as regards the interconnecting links of *all* realities, our personal worlds necessarily lack the assurance that what we know represents "the truth, the whole truth, and nothing but the truth".

In spite of all the progress that may be made by the specific sciences and the many partial truths that may thereby be revealed, the facts representing the 'whole truth' may continue to elude us for yet a long time, and deprive our personal mental worlds of the safest guide in our manifold searches.

I have purposely refrained from encumbering this concise analysis by details which might have tended to obscure the essence of the three concepts I ventured to put forward. They represent important handicaps in the search for truth; and to bear them in mind in controversial discussions may prove helpful.

[1] Spearman, "The Nature of Intelligence."

ROAD CONSTRUCTION IN WAR-TIME

In co-operation with the Ministry of War Transport, the Road Research Laboratory of the Department of Scientific and Industrial Research has now issued the second of a series of Wartime Road Notes*.

Road-building and road-maintenance in time of war differ in many respects and also in degree from peace-time practice. Not only are roads required for special and temporary purposes which demand different standards of design from those employed on the highways, but also speed in construction is vitally important and the use of local materials is a necessity. These war-time notes are intended to assist engineers in dealing with the special problems created by these conditions, and they present in brief form the latest findings of research and practical experience.

The recommendations in the first of these two publications refer to tar carpets (or thin surfacings) $\frac{3}{4}$–1 in. thick and surface dressings, and are based on systematic full-scale trials supported by laboratory investigations. Bituminous carpets of this description have been introduced quite recently and are capable of providing a non-skid surface having a reasonably long life and costing less than the British standard surfacings. The nature of the aggregate as well as its grading determines the quality of the carpet. Crushed rocks are preferable, but gravel may have to be used, and this has also been investigated. The recommendations, which can best be described as concise working instructions, cover the materials, the mixing procedure, and the laying of the materials on the road.

The second of the notes in this series has been prepared in collaboration with the Geological Survey and Museum, and supplies very necessary information as to the numerous sources in Great Britain of naturally coloured chippings such as might be used for surface-dressing roads and for similar purposes. It deals mainly with black or dark grey stones, and with the darker shades of red, brown and green. The colour of the rocks most widely quarried for use as roadstone are dark grey, pink, grey or buff, and whitish or pale brown or pale red as represented by such sources as Clee Hill basalt, Mountsorrel granite, dolomite and Hartshill quartzite. After describing the igneous rocks, the sedimentary rocks, metamorphic rocks and other potential materials, the note provides a valuable list of quarries arranged in three tables referring to three different groupings of colours.

Although an important consideration for the engineer, the question of strength is not discussed. It is stated, however, that the Road Research Laboratory is available at all times to answer inquiries or to amplify the contents of the notes where this is desired.

* Wartime Road Notes. No. 1: Recommendations for Tar Carpets and Surface Dressings. No. 2: Sources of Naturally Coloured Chippings in Great Britain. (London: H.M. Stationery Office, 1941.) 6*d*. each.

FOREST RESEARCH IN INDIA

The annual report on forest research in India and Burma is issued in two parts (Manager, Govt. of India Press, Delhi, 1940 and 1941). Part 1 is devoted to the Forest Research Institute at Dehra Dun; Part 2 to provincial reports for Burma and the provinces of India, all of which have special research officers in one or more of such branches of forestry as sylviculture, forest utilization, working plans and statistics, entomology and so forth. Perhaps only to those who witnessed the beginnings of research at the Forest Institute and out in the provinces of India and Burma are in a position to realize the great progress which the last three and a half decades have brought about in research problems in many branches of forestry. The reports must be consulted for a full appreciation of this statement.

That for the Institute for 1938–39 commences with the remark that although handicapped by serious financial restrictions the year in question had been for the Institute one of the busiest in its history; and the provinces, especially in sylviculture and forest utilization, appear to have been engaged upon equally important work.

The most numerous inquiries were in connexion with the manufacture of paper and ply-wood; but smaller industries such as the making of pencils, umbrella handles and cigarette-holders were equally to the fore. Other subjects had reference to suitable woods for semi-industrial purposes, such as the use of bamboo as reinforcement in concrete structures, and the chemical values of a large range of minor forest products—a branch so long neglected at the Institute owing to lack of funds. The co-ordination of the research of provincial research officers with that of the Institute involves a large amount of work—for inevitably the latter has to form a central clearing and co-ordinating centre for investigations carried out throughout India and Burma.

It has become evident that the staff sanctions for certain branches of the Institute in 1924 is no longer adequate to meet present-day demands. In connexion with minor products it is of interest to note that a permanent incumbent is to be appointed to the chemical branch of the Institute. This is apparently the result of a valuable report on the branch submitted by Dr. S. S. Bhatnagar, professor of chemistry at the University of the Punjab, after a visit to the Institute.

The War may have brought to the notice of smokers and the housewife that matches made in India are now on the English market. It was the Research Institute at Dehra Dun in the early years after the War of 1914–18 which assisted in establishing this industry in India. Umbrella handles have been mentioned above. In the days before the Institute a young Indian forest officer addressed a big umbrella merchant, stating that he had in his forests quantities of an excellent bamboo for umbrella handles. The price at length quoted by the merchant would not have paid for the cost of carriage of the bamboo from forest to the Indian coast! It required the establishment of the research institute to enable such problems to be elucidated—for research paves the way to utilization.

FORTHCOMING EVENTS

SATURDAY, OCTOBER 18

NUTRITION SOCIETY (at Cambridge).—Conference on "The Evaluation of Nutritional Status". (See page 433 of last week's issue.)

THURSDAY, OCTOBER 23

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 4 p.m.—Sir Noel Ashbridge: Inaugural Address.

FRIDAY, OCTOBER 24

INSTITUTION OF CHEMICAL ENGINEERS (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Sir Richard Gregory, Bart., F.R.S.: "Scientific Knowledge and Action" (Fourth Hinchley Memorial Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. W. A. Stanier: "The Position of the Locomotive in Mechanical Engineering" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MAINTENANCE ENGINEER—The Borough Electrical Engineer and Manager, Halifax Electricity Department, 19–23 Northgate, Halifax (endorsed 'Maintenance Engineer') (October 21).

LECTURER IN CHARGE OF THE MARINE ENGINEERING SCHOOL, Hull Municipal Technical College—The Director of Education, Guildhall, Hull (October 27).

INSPECTOR OF SCHOOLS (WOMAN)—The Director of Education, Education Offices, Deansgate, Manchester 3 (October 31).

ENGINEER AND MANAGER of the Belfast Gas Undertaking—The Town Clerk, Belfast (November 5).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 2, No. 12: The Avian Ulna, its Quill-Knobs. By Dr. George H. Edington and Agnes E. Miller. Pp. 138–148+8 plates. (Edinburgh and London: Gurney and Jackson.) 3s. [249

Proceedings of the Royal Irish Academy. Vol. 46, Section A, No. 12: On some Applications of Quaternions to Restricted Relativity and Classical Radiation Theory. By P. Weiss. Pp. 129–168. 2s. Vol. 46, Section A, No. 14: Further Studies on Solving Eigenvalue Problems by Factorization. By E. Schrödinger. Pp. 183–206. 1s. Vol. 46, Section B, No. 11: Investigations on Grey Speck Disease in Oats on some Irish Soils. By Patrick H. Gallagher and Thomas Walsh. Pp. 143–160+plates 11–14. 2s. Vol. 46, Section B, No. 12: The Behaviour of the Osmic Reducing Substance of Protozoa during Cell Division. By J. Brontë Gatenby. Pp. 161–172+plate 15. 1s. Vol. 46, Section B, Nos. 13, 14: Studies in Irish Quaternary Deposits. 2: Some Lacustrine Deposits near Ratoath, Co. Meath; 3: The Reindeer in Ireland. By G. F. Mitchell. Pp. 173–188. 1s. Vol. 46, Section B, No. 15: The Morphology of the Osmiophile Material in some Ciliates. By J. D. Smyth. Pp. 189–206+plates 16–18. 1s. 6d. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [249

Lecture on The Use of the Spekker Photo-Electric Absorptiometer in Metallurgical Analysis. By E. J. Vaughan. Pp. 48+7 plates. (London: Institute of Chemistry.) [249

Chromatographic Analysis. By Dr. A. H. Cook. Pp. 36. (London: Institute of Chemistry.) [249

Freshwater Biological Association of the British Empire. Scientific Publication No. 5: A Key to the British Species of Freshwater Cladocera with Notes on their Ecology. By D. J. Scourfield and Dr. J. P. Harding. Pp. 50. (Ambleside: Freshwater Biological Association of the British Empire.) 1s. 6d. [249

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 23, 1940. Pp. iii+255+25 plates. (Sheffield: The University.) 7s. 6d. [269

City and Guilds of London Institute. Report of the Council to the Members of the Institute for the Year 1940. Pp. xlviii. (London: Gresham College.) [269

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 12, No. 4: March 1941. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+227–310. (London: H.M. Stationery Office.) 4s. 6d. net. [269

Caradoc and Severn Valley Field Club. Record of Bare Facts for the Year 1940: a List of the More Noteworthy Observations made by Members of the Caradoc and Severn Valley Field Club and Others. (No. 50.) Pp. 44. (Shrewsbury: Caradoc and Severn Valley Field Club.) [299

Dove Marine Laboratory. Report for the Year ending July 31, 1940. (Third Series, No. 8.) Pp. 16. (Cullercoats: Dove Marine Laboratory.) 5s. [110

Other Countries

Colony of Mauritius: Department of Agriculture. Eleventh Annual Report of the Sugarcane Research Station, 1940. Pp. 32. (Port Louis: Government Printer.) 40 cents. [179

British Honduras. Abridged Report of the Forest Department for the Year ended 31st December 1940. Pp. 4. (Belize: Forest Department.) [179

Imperial College of Tropical Agriculture. Tenth Annual Report on Cacao Research, 1940. Pp. 33. (Trinidad: Government Printing Office.) 5s. [249

U.S. Department of Agriculture. Circular No. 607: The Black Grain Stem Sawfly and the European Wheat Stem Sawfly in the United States. By E. J. Udine. Pp. 9. 5 cents. Technical Bulletin No. 775: The Yellow Chapote, a Native Host of the Mexican Fruitfly. By C. C. Plummer and M. McPhail. Pp. 12. 5 cents. Technical Bulletin No. 778: The Biology and Control of the Sorghum Midge. By E. V. Walter. Pp. 27. 10 cents. (Washington, D.C.: Government Printing Office.) [249

U.S. Office of Education: Federal Security Agency. Biennial Survey of Education in the United States, 1938–40. Vol. 1, Chapter 6: School Hygiene and Physical Education. By Dr. James Frederick Rogers. Pp. iii+27. 5 cents. Vol. 1, Chapter 7: Practices and Concepts relating to City Boards of Education. By W. S. Deffenbaugh. Pp. iii+27. 5 cents. Bulletin 1940, No. 6 (Monograph No. 3): Financing of Schools as a Function of State Departments of Education. By Timon Covert. Pp. vi+34. 10 cents. Bulletin 1940, No. 9: Education and Service Conditions of Teachers in Scandinavia, the Netherlands and Finland. By Alina M. Lindegren. Pp. vii+149. 20 cents. Bulletin 1940, No. 11: Financial Aids for College Students. By Fred J. Kelly and Ella B. Ratcliffe. Pp. v+35. 10 cents. Education and National Defense Series, Pamphlet No. 15: Education under Dictatorships and in Democracies. Pp. vi+19. 15 cents. (Washington, D.C.: Government Printing Office.) [249

Newfoundland: Department of Natural Resources. Act No. 28 of 1934: An Act respecting Game, Fur-bearing Animals and Inland Fisheries, with Amendments to April 14th, 1941, also Regulations issued thereunder in effect as at April 14th, 1941. Pp. vi+34. (St. John's: Department of Natural Resources.) [249

Astrographic Catalogue 1900·0. Sydney Section, Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 21: R.A. 0h. to 6h., Dec. −56° to −58°, Plate Centres Dec. −57°. Pp. 30. (Sydney: Government Printer.) [249

Smithsonian Miscellaneous Collections. Vol. 99, No. 22: The Ice Age Problem. By Walter Knoche. (Publication 3633.) Pp. ii+6. (Washington, D.C.: Smithsonian Institution.) [249

Smithsonian Institution: United States National Museum. Bulletin 177: The Herpetology of Hispaniola. By Doris M. Cochran. Pp. vii+398+12 plates. 70 cents. Contributions from the United States National Herbarium, Vol. 28, Part 4: Plants collected by R. C. Ching in Southern Mongolia and Kansu Province, China. By Egbert H. Walker. Pp. vi+563–675+vii–xii+plates 21–27. 30 cents. (Washington, D.C.: Government Printing Office.) [249

Indian Forest Records (New Series). Entomology, Vol. 6, No. 8: Immature Stages of Indian Lepidoptera (2) Noctuidæ, Hypsidæ. By J. C. M. Gardner. Pp. 253–298+2 plates. 2.4 rupees; 3s. 9d. Silviculture, Vol. 4, No. 3: Notes on Cultivation of the Tung-Oil Tree (Aleurites spp.) in India. By M. V. Laurie and J. N. Sen Gupta. Pp. v+133–160+2 plates. 1.10 rupees; 2s. 6d. (Delhi: Manager of Publications.) [269

Survey of India. General Report, 1940, from 1st October 1939 to 30th September 1940. Pp. vi+43. (Calcutta: Survey of India.) 1.8 rupees; 2s. 6d. [269

Report for the Year 1940 of His Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty. Pp. 8. (Cape of Good Hope: Royal Observatory.) [299

Proceedings of the United States National Museum. Vol. 90, No. 3109: A History of the Division of Vertebrate Palæontology in the United States National Museum. By Charles W. Gilmore. Pp. 305–378. Vol. 90, No. 3112: Cestode Parasites of Teleost Fishes of the Woods Hole Region, Massachusetts. By Edwin Linton. Pp. 417–442+plates 60–62. Vol. 90, No. 3115: Notes on Mexican Turtles of the Genus Kinosternon. By Leonhard Stejneger. Pp. 457–460. (Washington, D.C.: Government Printing Office.) [299

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 10: Expressions on Education by Builders of American Democracy. Pp. viii + 90. (Washington, D.C.: Government Printing Office.) 20 cents. [299

Catalogues

Cooke Horizontal Comparator. (Publication No. 887.) Pp. 20. (York: Cooke, Troughton and Simms, Ltd.)

A Collection of Books on the History of Bacteriology and other New Acquisitions in the History of Science including some fine Early English Medical Books. (Catalogue 64.) Pp. 40. (London: E. P. Goldschmidt and Co., Ltd.)

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NATURE

SATURDAY
OCT. 25, 1941

THE BEHAVIOUR OF GERMANY

"*Why and how are words so important that they can not be too often used.*" (Napoleon.)

DETACHMENT for a moment from the stress of personal circumstances and the attempt, howevêr humble, to view with cool sanity world affairs of the moment, at once bring an uncomfortable feeling of bewilderment. More than that, there is a very present sense of something evil. Things accepted as obvious truths or the plain commonsense of everyday behaviour have gone by the board : so much of mankind is acting and thinking as if the simplicities of truth and honesty, fair dealing and plain speaking, self-respect and respect for one another, all the great whole summed up in the words 'do as you would be done by', are no longer valid, are indeed no more than the outworn catchwords of a grandmotherly age.

If the ordinary man in the street ignores these primary rules of conduct we call him neurotic, criminal or insane, according to the degree of departure from the ordinary. Does the same standard apply to nations ? Here we might listen to the psychologists, who hold an insight into the springs of conduct deep in every human purpose. One of them, H. G. Baynes, a practising psychologist, with the additional advantage of an intimate acquaintance with Germany and the Germans before the War, has recently put forward this approach in his book "Germany Possessed"*. It is not at all technical but a serious study of one of the great problems of humanity, meant for the man in the street intelligent enough to see beyond his own parochial boundaries.

Civilization, General Smuts has said, is undergoing a spiritual migration ; it is on the march. Something is happening. Our own lives have been made a mess of, caught up as we are in the sweep of something quite beyond ourselves. What then can be done for the others treading so closely behind ? The hurrying years do not leave so very much time wherein to take thought for the morrow.

At the root of it all lies this German business ; could we but grasp that, perhaps the horizon might be clearer. Still holding to that detachment, still accepting as fundamental that every human being is entitled to his own opinion, to be himself, what has happened to the kindly, beer-drinking, musical, philosophic, rather fat and middle-aged German that Carlyle knew ? The Germans have changed ; it is not the old Germany of before 1870, it is not even the Germany of the War of 1914–1918 ; it is something utterly different, and what is more, something utterly worse, something utterly vicious. It is again "the great blond beast avid and rampant for plunder". It is the *furor teutonicus*

* "Germany Possessed". By H. G. Baynes. Pp. 305. (London: Jonathan Cape, Ltd., 1941.) 16s. net.

of which Heine wrote in 1834: "and should that suborning talisman the Cross, break, then would come crashing and roaring forth the wild madness of the old champions, the insane Berserker rage of which the Northern poets say and sing. That talisman is brittle and the day will come when it will pitifully break."

Discarding wishful thinking and looking at things as they really are, one or two points stand out. The first is that the Germans really do mean it. It is absurd to imagine that the great mass of a mighty nation are being in any sense led, badgered or cajoled by a system which they do not accept into conduct of which they do not approve. The Germans would be quick enough to accept the spoils of victory if Hitler won. To suggest any other than that Germany is solidly behind the Nazi regime is to be blind to the history of the last hundred years.

A second point takes in the political thesis of the totalitarian State. Again the Germans do mean it. They accept and believe in, nay, passionately uphold, the doctrines of National Socialism. The very words are a contradiction in themselves, for it is not national save in its claim for the rights of the *Herrenvolk*, and not socialism save in the complete subordination of every living person to the over-riding mastery of an irresponsible rule. Hitler himself has said: "There will be no licence, no free space, in which the individual belongs to himself. This is Socialism—not such trifles as the private possession of the means of production." We prate freely of the ideals of democracy, as if they were self-evident truths, and dismiss in so many words any possible challenge in ethic or in fact. It were surely better to think quietly what it all means, what are the arguments behind it, which is the pith of this convulsion that has swept through the German people. That it is gravely wrong, there is no doubt. But we shall have to go on living with the German people afterwards, and perhaps if we could understand their error it might be better than merely punishing them for it.

No one can be literally free, for everyone is in himself at once the duality of an individual and a social unit. But the claims of the latter aspect bear upon all, are settled jointly and equitably, are granted, not taken. There are, moreover, advantages in counterbalance. That is in essence the principle of democracy. The differences implied in theory or in practice between the English, the American, the Chinese and the Russian standards are matters of detail, not of principle, which can be comparatively easily reconciled. It is largely a question of how much to render unto Cæsar.

The totalitarian idea says something quite different. The individual here is allowed no personal existence whatsoever, he is not himself in any sense at all except as one of the subordinate items of a multiple unit, just as in the exquisite harmony of the body, a cell in the skin, the liver, or the lung, is admittedly self-contained and is yet entirely bound up in the maintenance of a whole. The philosophy of the 'total State' claims to determine the place of every man. "The state is the absolute, the will that became substance." So Hegel, and so Fichte, Schopenhauer, Nietzsche, and others, in the will to power, the superman, the good of all before the good of one, and such-like phrases. It is interesting, by the way, to notice that the great prophets of the Nazi regime, Hegel and Nietzsche, both took pains to emphasize their dislike of Germany. "It is part of my ambition to be considered as essentially a despiser of Germany", is another quotation from Hegel not so often met with.

We may find it amazing that a nation, which has contributed so greatly to the progress of humanity, should have reverted to cynically deliberate fraud, cold-blooded murder, revolting and atrocious cruelty; but we ought not to find it surprising, for these are but the logical derivatives of the principle that might is right. Further, as has been said, Germany means it, Germany in the sense of the ordinary man in the street, who has put Hitler where he is and Germany where she now stands.

It would be interesting to trace the rise of the evil in Germany, the change that has overtaken her in the last hundred years or so, and to try to give proportionate weight to the many contributory and interacting factors, but this is not the time. Even allowing that many circumstances had effect, their import would still not really explain this strange phase. One senses the presence of something not normal, something evil, something insane. It is here that the study of emotional urges, or motivation, has its place.

People are thinking and talking about the rationale of German conduct; a recent leading article in the *Daily Telegraph*, inspired by many letters sent in, asks pertinently whether the soul-state that has produced Nazism is transient or congenital.

Psychology takes in not only the individual but also the crowd. It has long been recognized that any group of people, even as big as a nation, tends to react as a unit, that there can be a synthesis of separate mind-entities when diversity is momentarily or temporarily subordinated to a homogeneous and concerted feeling, impulse or action. In mass, an aggregate of isolated minds is capable of coalescing into something distinct, something coherent, something bigger. The subject may be further pursued in such books as Trotter's "Instincts of the Herd", or le Bon's study "La Foule".

Baynes puts forward the view that the collective unconscious of the German people has been swept into a hysterical outbreak, a reaction into an irreconcilable and unacceptable attitude, emotional, not consciously realized and considered. That is to say, not rational. There are, of course, two obvious factors, the intrinsic, that is, the nature of the people concerned, and the extrinsic, that is, the circumstances in which they found themselves. That their situation was difficult and unpleasant we may at once concede. But that in no sense implied the need of irrational and indeed non-moral response. At no time in the last twenty years have the problems of Europe been incapable of solution on moderate give-and-take grounds. But the path of Germany has been a subordination at every step to wild impulses of hatred and revenge, to the irrational, emotional, aggressive, behaviour of a child, which, of course, ultimately defeats itself.

This tendency has, indeed, been noted by independent observers. Lawrence of Arabia during a visit to Germany so far back as 1923 wrote with a strange prescience: "You stiffen your backbone and you listen to the night. There is a sense of danger. It is not the people. They don't seem dangerous. Out of the very air comes a sense of danger, a queer, *bristling* feeling of uncanny danger. Something has happened. Something has happened which has not yet eventuated. The old spell of the old world has broken, and the old bristling, savage spirit has set in . . . and it is a happening of far more profound import than any actual *event*. It is the father of the next phase of events." Jung in 1936 saw clearly the cruel force pressing upon Germany. "Germany is a land of spiritual catastrophes, where certain facts of nature allow only a patched-up peace with reason." These two very apposite quotations are taken from Baynes's "Germany Possessed".

Crowd psychology holds yet another quality in the curious, again irrational, yet vivid, immediate and intense response to a certain type of individual. The type so able to influence the collective unconscious has something of the mystic about it. They are intuitives, themselves receptive of and guided by impulses without the ken of the ordinary man. Intuition is probably present to a small extent in every one, to a distinct degree in a limited number, and notably so, very rarely. Certain individuals are undoubtedly capable of undergoing states of consciousness in which they would appear to make an unusual contact with the realities of space and time. Joan of Arc provides a good example. A poor country girl, she heard voices bidding her take up the redemption of her people; she succeeded in imposing her will not only on an ignorant peasantry but also on the first soldiers of France, and swiftly transformed the whole military situation. There are other instances in history of the same sort of thing, explanation of which is not easy.

The German Fuehrer is one of these "daemonic" personalities. His strange and obscure life, his peculiarities of behaviour, his childish tempers, his prejudices, his intuitions, his inspirations ("waiting until he knows"), and his intense and vehement power over a German audience stamp him as something unusual. Note that it is not just the credulous man in the street whom he has swept along with him; it is also the hard-headed German General Staff and much of the intelligentsia. All this makes the greater pity that with such gifts he should have given his country's policy the sinister twist of these last years.

Is Germany then in the throes of an intense mass movement, a crowd hysteria, a surge of the old savage unconscious rushing down the slope of the irrational, the childish, the neurotic? Can their compulsive drive against, not some, but all their fellow-men, be so explained? Their actions are not normal. Their causeless suspicions, as of 'encirclement' and against Russia; their intense need for self-assertion, the sure stamp of inferiority, as in the '*Herrenvolk*' and the 'Aryans'; their crudity; their cruelty; their lack of every decency. To be suspicious, to break faith, to lie, to cheat, to murder—the common man knows that it does not work. There is no need of moral words, it simply does not work. How then can the Germans do these things? There can only be one outcome. Therein lies support for the conception of a nation "possessed".

Of course, there are obvious difficulties. The whole subject is new and unexplored. Patient and persistent study not only of this episode but also of many others is demanded to reinforce such a hypothesis, no matter how feasible. That Germany has stepped down from the climbing stairs of civilization into some callous, cynical, egocentric crudity cannot be altogether accepted as a new phase. Frederick the Great with all his good qualities was not conspicuous for keeping faith; Bismarck was responsible for the episode of the Ems telegram; and we all remember something about a 'scrap of paper' in the War of 1914–18. German atrocities are not a new story; they were spread, with some justification—to use restrained language—in 1870 and in the last war. German philosophy has been alone in advancing doctrines to which German conduct to-day gives but the logical expression. In short, their present state of mind cannot be altogether regarded as unexpected; it could even be legitimately argued that Germany was the only nation from which such

might have been expected. Alternatively, there may be something in the national make-up rendering them more unstable, more suggestible, more liable to some such breakdown.

"Germany Possessed" offers a sane and serious study of the why and how of all this unpleasant muddle. More than that, it dispels with a happy insistence the traitor doubts that may beset even an honest mind and a clear conscience. It submits a contribution certain to be helpful in the ultimate problems that will clutter up so heavily the final disentanglement. Without necessarily agreeing with every detail, everyone can find in Baynes's book much to approve, much that is reasonable and much that is encouraging. That it may superficially appear without immediate practical application is untrue; mankind advances not in arithmetical but in geometrical progression. The alarming hypothesis of yesterday is the happy certainty of to-day. Psychology may be a new science, it may submit surprising, perhaps revolutionary, concepts, but its admitted conquests in the individual field insist that it be at any rate heard in the collective sense. The mere appearance of such a thesis at this present moment justifiably infers that even under the vivid edge of a cruel conflict man can still hold to the high, ardent and vehement purpose of co-operation in the conduct of this life. Difficult, yes; but then ideals are made that way.

DESERT SANDS AND DUNES

The Physics of Blown Sand and Desert Dunes
By R. A. Bagnold. Pp. xx+266+16 plates. (London: Methuen and Co., Ltd., 1941.) 24*s.* net.

LIEUT.-COLONEL BAGNOLD is well kno for his scientific publications on desert sands and dunes, and for a book describing his travels in the Egyptian and Libyan Deserts. The present book combines these papers and much other original research into one comprehensive volume, which would, however, have possessed an added interest to readers if the introduction had included some reference to the author's work as a pioneer of motor travel in the desert. Descriptions of desert features in various parts of the world have been written by many travellers, but this book is unique in that the author has combined the results of experimental research in a wind tunnel with personal observations in the desert. The subject has a particularly topical value in connexion with the present war operations in the Libyan Desert, and the explanations of many desert features vitally affecting such operations will interest a wide range of readers. There is also scope for applying the researches to other kindred problems, such as the encroachment of desert sands over cultivated land, which is a serious menace in certain parts of the United States.

The contents of the book are divided into three sections dealing respectively with the physics of grain movement, small-scale effects such as surface ripples and ridges, and large-scale dunes. The first section shows in a fascinating way the mechanism of the interaction between sand grains and wind, as observed both in the desert and in the wind tunnel. Contrary to popular impression, dust storms in which fine particles are carried to a considerable height in suspension in the air are of comparatively rare occurrence in the true desert country. Sand grains can be lifted by the wind only to a height of several metres at the most, and the author shows by photographs and diagrams how the bulk of the sand movement is limited to a height of a few inches above the desert surface. These sand grains travel in a succession of leaps alternating with impacts on the surface grains, the process being given by the author the name of saltation. There is also a slow creep of the surface grains due to the impact of the grains in saltation, the whole process being considerably affected by the size and nature of the desert floor deposit.

The second section deals with an original method devised by the author to express graphically the size grading of sand deposits, and the application of this method to a study of deposits formed under varying conditions of wind velocity. Small ripples formed on the sand surface are shown to be entirely different in origin from the familiar ripples left on the ocean shore, in spite of the similarity of appearance.

The third section, on large sand dunes, is of a descriptive nature, since the scale of formation is beyond the scope of laboratory imitation. Although some of the theory advanced is admittedly tentative, the author has built up a convincing explanation of how sand dunes rising to a height as great as a hundred metres and extending for nearly a hundred kilometres, may be formed by the interplay of varying winds acting alternately from different directions. The enthusiasm of the author is shown by an account of experiments to determine the internal structure of the dunes which involved pouring precious water over the surface, the different layers being distinguished by the rate of seepage. The final chapter, which

should really have been an appendix, since it is not necessarily a large-scale effect, describes the so-called singing sands. The solution of this problem has not yet been attained, but the account of preliminary experiments shows that the author has made considerable progress in this problem and will no doubt find a successful explanation when he is able to relinquish his present duties.

Although written primarily for the geologist and civil engineer, many sections of the book will be of great help to those engaged in other branches of science. Thus the section on the grading of desert sands could be applied to many industrial powdered materials; the theory of the motion of sand grains under the influence of wind action could also be applied to the movement of dust in mine galleries, to deposits of dust in large pipe lines and indeed to pneumatic conveying of granular materials in general. Apart, however, from its specific applications to definite problems, the general reader will be rewarded with a fascinating description of a natural phenomenon which appeals strongly to the imagination.

H. HEYWOOD.

EDUCATION YESTERDAY AND TO-DAY

Education To-day

By John Dewey. Edited, and with a Foreword, by Joseph Ratner. Pp. xvi+86. (London: George Allen and Unwin, Ltd., 1941.) 5*s*. net.

SINCE the end of the nineteenth century, John Dewey has been the most effective force in the development of American education, while on this side of the Atlantic he has won for himself a large body of disciples, and the influence of his reforming zeal may be seen in British schools as well as in those of the United States. Many teachers will, therefore, welcome the publication of this volume of essays, written between 1897 and 1908, and selected from the large *corpus* of his writings to give the dominant themes of his educational work. These are summarized in "My Pedagogic Creed" (1897), which forms the first chapter of the book, and the relevant articles are then applied in a series of essays on "The Primary-Education Fetich", "The People and the Schools", "The Place of Manual Training in the Elementary Course of Study", "Democracy in Education", and "Religion and Our Schools". Some of these are inevitably dated, and the battles for which Dewey fought thirty or forty years ago have been largely won: yet the victory has nowhere been so complete or so secure that all danger of a counter-attack is removed, and though the title given to this book is rather misleading, yet its contents have a relevance to the problems of to-day which cannot be ignored, and they are shot through and through with flashes of universal truth and wisdom which make them independent of time and place.

One of Dewey's chief services to education has been to humanize it. For him, all its subjects and activities, whether considered from the teacher's or the learner's point of view, must be translated into terms of human nature, and be made relevant to human needs and human interests. We get away from the false but common view that education is an operation we perform on somebody else (and nearly always exclusively on his mind), to the truth that it is always a co-operation, and a co-operation in which the *whole* of both partners to it is concerned: it is the whole child who is being educated, the whole man who is educating him, and the process is not an action which the one carries out on the other, but a transaction between the two. In these thoughts we have "the controlling factors in the primary curriculum of the future—manual training, science, nature-study, art and history. These keep alive the child's positive and creative impulses, and direct them in such ways as to discipline them into the habits of thought and action required for effective participation in community life." Thus education becomes "a process of living, and not a preparation for future living", the school "a social institution", and the synthesizing force in a child's school subjects and activities his own social activities. The culture we teach must not be a "hand-me-down garment", an "intellectual suit which other people have worn", but the natural culture of childhood, adolescence, and manhood, a culture compounded of many elements, among which the technical and the spiritual will both have their place. Religion is to be taught not as a body of doctrine, but as a way of life—and the way of life is to be seen in the common life of the school: the schools "serve best the cause of religion in serving the cause of social unification", and the intellectual integrity which they teach is potentially much more religious than any outworn belief which it may displace.

The teacher's human needs must be considered too, and the chief of these is the "recognition of his intellectual and spiritual individuality": he must be trusted, and his judgment upon matters of educational importance (whether inside the school or outside) must be respected and effective: otherwise we have an undemocratic education for

a democratic community. It is men, not walls, that make a city, but education makes the men, and the educational system, if it is to do its work, must reflect and "simplify existing social life".

It is along these lines that Dewey fights his battles. Are the battles won? There is much to encourage us, but there is also much to make us uneasy. In Great Britain since the beginning of the century we have done much to put the child in the centre of the picture, and we remember more often than we did that it is John and Mary whom we are teaching, and not arithmetic or reading. But there are still far too many teachers 'subject-ridden' (What is a 'subject', and how does it differ from our 'object'?). From the totalitarian States there is developing a strong attack on the whole theory of education as a human activity, and there will be repercussions of this among the democracies. Culture is in danger of becoming the preserve of the educated few, and one of the chief problems of our day is that of synthesizing cultural and vocational activities. To judge from the B.B.C. material, religion and religious education are hardening in the cement of orthodoxy. While teachers are ostensibly free, they are perhaps the least trusted of all professions, and their influence on educational policy is dangerously restricted: it is an ominous sign that proposals for education after the War should have been prepared for the Board of Education by its Civil Servants as a confidential document, and should be kept from the teaching profession. Assuredly, the republication of Dewey's "essays" is not untimely.

M. L. JACKS.

THE STRENGTH AND STRUCTURE OF THE EARTH

Strength and Structure of the Earth
By Prof. Reginald Aldworth Daly. (Prentice-Hall Geology Series.) Pp. x+434. (New York: Prentice-Hall, Inc., 1940.) 3.50 dollars.

THOSE who have some acquaintance with Prof. Daly's researches and writings will expect both pleasure and profit from his latest book; nor will they be disappointed. Geophysics demands the co-operation of workers in a number of different sciences, and with the modern tendency of research to run along narrow paths there are few who have the wide knowledge required for a grand synthesis. Thus, there has from time to time been a cleavage of opinion on various vital matters between, say, geologists and mathematical physicists, although each had much to learn from the other. Happily, there has arisen in recent years a spirit of close co-operation, and some of the fruits of it are seen in the volume under review. Prof. Daly combines the wide knowledge of the geologist with a clear grasp of the modern advances in geodesy and seismology—no mean achievement. His exposition is attractive, and is illuminated by a wealth of suggestions, many of them frankly speculative, many indicating possible quantitative tests, and all of them worth recording.

The reader who is three-quarters of the way through the book will notice that so far the book had dealt exclusively with isostasy; indeed, it might be asked why the title is not simply "Isostasy". Had the last chapter been omitted and the remaining eleven chapters been left as a treatise on isostasy itself, the book would still have been worth the writing. The final chapter, however, on the strength of the earth-shells, could not have been written except in the light of a detailed description of the results of geodetic surveys. The wide acceptance of the idea of isostasy has afforded excellent illustrations of the use and misuse of inductive inference. As a working hypothesis, based on a large body of data, there has from the first been much to recommend it; the too-ready acceptance of an over-simplified model apparently gave some writers the impression that world-wide isostasy was a fundamental law, even though not more than two per cent of the earth's surface had been gravitationally surveyed.

In this book great care has been taken to put the development of the idea of isostasy in its proper historical setting. It was Pierre Bouguer who in 1749 stated in his book, "La Figure de la Terre", his belief that the measurements made between 1735 and 1745 on the meridian arc in Peru indicated a much smaller attraction of the Andes than their estimated mass would suggest. Shortly afterwards R. J. Boscovich attributed this to a thermal expansion of material in depth; he suggested that the deficiency or void ("vide") within the mountain compensates ("compense") for the overlying mass. In 1836 Sir John Herschel expressed the view that the removal of rocks by erosion to distant basins would entail horizontal flow of the plastic matter below. F. Petit, too, had proved in 1849 that the agreement of the astronomical and geodetic latitudes of Toulouse indicated a deficiency of attracting matter beneath the Pyrenees. Thus the ground was to some extent prepared for the classic work of Archdeacon J. H. Pratt, whose first paper was read in

December 1854, and of Sir George Airy, whose paper was read in January 1855. In the course of Everest's triangulation of India it was found that the difference between the geodetic latitudes of two stations, Kaliana and Kalianpur, on the same meridian, was not the same as the difference of their astronomical latitudes; the difference, in fact, was about 5″. Pratt calculated the deflecting effect of the attraction at these stations of High Asia, and on this basis predicted a difference of about 16″, almost exactly three times that actually observed. Later work by Pratt took account of the relatively weak attraction of the ocean to the south of India. Airy remarked that, surprising as Pratt's discovery was, it might have been foreseen on the current view of a fluid interior of the earth (or at any rate fluid at the time mountains were formed); he showed that on likely hypotheses the crust was not strong enough to hold up the mountains, and attributed their support to projections of the light crust downwards into the denser matter on which the crust was, in effect, floating—somewhat after the fashion of a floating iceberg. Hence the idea of the 'roots of the mountains'. Pratt, working on the idea of vertical expansion of large blocks of the crust, supposed the attenuation of density to be distributed uniformly to a certain depth, which for High Asia he estimated as about 100 miles. Between these two models one could evidently construct any number of others in which the two modes of compensation are combined. The word 'isostasy' was coined in 1889 by C. E. Dutton for the ideal state of equilibrium of a fluid or plastic heterogeneous body, and the question he proposed was: How nearly does the earth's figure approach to isostasy? Substantial extracts from the original papers of Pratt, Airy and Dutton are quoted by Daly. Measurements of the intensity of gravity tell the same story as measures of deflexion of the vertical.

Much of the book is taken up with a description of the way in which the approach of the earth to isostatic equilibrium has been tested by plumb-line and pendulum. The very fine work of J. F. Hayford and W. Bowie in the United States showed that that country approximates closely to the isostatic state; for their reductions they used a Pratt type of compensation extending to a depth of 113·7 km. Their results rather led to the expectation that isostasy would prove, to a close approximation, to be a world-wide phenomenon; they suggested, too, that compensation followed the Pratt model. A very important paper by Heiskanen in 1924 showed that the available European data indicated on the whole a close approach to isostatic balance, and that there was very little to choose between the Pratt and the Airy types of compensation, a result that was also true of gravity in the United States. Within the last ten years new observations have greatly changed the outlook. Hunter and Glennie have shown that India departs notably from the isostatic state, and the measurements of gravity by Vening Meinesz during extensive voyages in a submarine have revealed large belts of astonishingly large gravity anomalies. None the less it is still convenient to collate the observations by adopting an isostatic model and to speak in terms of deviations from complete isostasy.

A chapter on "Nature's Experiments with Ice-caps" brings us nearer to the main purpose of the book. The post-Glacial uplift of Fennoscandia, which still seems to be continuing at a measurable rate, is generally ascribed to isostatic adjustment following the removal of the ice-sheet; a similar recoil is found in north-eastern North America. Estimates of the viscosity of the underlying material have been made, but the data, and the use of the data, are decidedly precarious. The outstanding problem that geodesists and geophysicists hope to solve is whether the material below the 'crust' behaves in the long run as a fluid, or whether it has residual strength; this weak layer is termed the 'asthenosphere'. A related problem is the extent to which the crust can bear loads without fracturing, that is, the horizontal extent of the supposedly independent crust-blocks.

The researches of Jeffreys, which indicate in the asthenosphere a strength approaching that of granite, are seriously challenged by Daly, who readily admits that there are too many unknowns in the problem to permit at present of a unique solution. Daly suggests that below the asthenosphere, and probably extending down to the fluid, dense core of the earth, is a "mesospheric shell" of moderate strength and of density somewhat greater than at the asthenospheric level; this strength and density are held to arise through crystallization under pressure. The suggestion is made that the asymmetry of figure of the earth may arise from a permanent inequality in the mesospheric shell, the imperfectly healed wound left when the moon was torn away from the earth—a new variant of an old theory originally due to Osmond Fisher. An attempt is made to account for deep-focus earthquakes, but it is doubtful if the sudden freezing of a sunken mass of glass would release sufficient energy.

This stimulating treatise is illustrated by a large number of excellent clear diagrams, and the type is easy to read. The computations have evidently involved the author in much hard work, and he has done a great service in collating and rendering easily accessible the results of a number of researches scattered through a wide range of publications.

R. STONELEY.

The Aeroplane of To-morrow
By Noel Pemberton-Billing. Pp. 307. (London: Robert Hale, Ltd., 1941.) 12*s.* 6*d.* net.

THIS is a difficult book to review. One does not dare to dogmatize about anything in the aeronautical world, but the science of flight is now becoming sufficiently established to enable us to look a short way ahead with reasonable certainty. The author's conclusions as to how progress in speed or carrying capacity of heavier-than-air craft can be made, in general by an increase in wing loading, are certainly true; but the light-hearted way in which the book sweeps away, or else ignores, the attendant difficulties, rather shakes one's faith in it as a serious scientific work.

The principal part of the book is devoted to an elaboration of the author's idea of a "slip wing" aircraft, a form of assisted take-off for a highly loaded aircraft (already developed by the Short-Mayo flying-boat) evidently by his assistant, Mr. Roger Tennant, whose work he acknowledges. His figures quoted for a suggested long-range high-speed bomber are accurate aerodynamically, but in the event of a failure necessitating an emergency landing immediately after commencing a flight, the whole of the bomb and petrol loads would have to be jettisoned, and even then the author contemplates landing with a wing loading of 40 lb. per sq. foot. This is scarcely a happy procedure in the vicinity of a crowded aerodrome. This is admittedly an isolated case, but it is typical of the whole book. The best that can be said is that it puts the case of one particular avenue of possible progress in plain language such as can be read by the ordinary man, and in this sense it is useful and worth reading. One looks in vain for anything new, which the title rather leads us to expect, or anything that is not already known by serious students of aeronautics.

Intermediate Inorganic Chemistry
By Dr. J. W. Mellor. New edition, revised by Dr. H. Irving. Pp. xx+690. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 9*s.*

THE revision of this book has been carried out by Dr. Irving, who states in the preface that "he has been at pains to preserve the essential character of the book". Thus, while the numerical data have been extensively revised, only minor changes have been made to the subject-matter. The reviewer feels very strongly, however, that it would have been worth the extra cost of repagination to have omitted many of the old graphical formulæ, as well as details of, for example, hyponitrous acid, hydrazoic acid and the thionic acids, which are scarcely suitable for students at this stage. Incidentally, this would have provided space for the inclusion of one or two modern processes, such as the manufacture of nitric acid from ammonia, which ought to have been mentioned in this edition. Apart from these criticisms, and perhaps the debatable point of whether it was wise to omit the electronic theory of valency, the reviser appears to have accomplished his task successfully. A. C. C.

Honeycraft in Theory and Practice
By J. A. Lawson. Cheaper edition. Pp. xii+228+18 plates. (London: Chapman and Hall, Ltd., 1940.) 3*s.* 6*d.* net.

THIS is a reprint of one of the best-planned books on practical bee-keeping known to the reviewer. The author perhaps allows his own preferences too much scope in his exclusive recommendation of the Italian bee, and in confining attention to the 'Stoney-Archer' type of hive, although the latter, in a simplified form, is now well known and widely used under the name of 'National Standard'. The W.B.C. type —still the hive most used in Great Britain, and well suited to the climate—is dismissed in a few lines of criticism. Considerations of space would, however, probably make impossible the adequate description of more than one hive type; and the author's is a good choice.

It is to be regretted that the book has not been brought up to date in the many matters of biology and physiology, and of the physics of honey, in which knowledge has advanced since its first publication in 1931. Some of these are of practical value, and all of interest to the intelligent beekeeper. It is to be hoped that this will be remedied in a future edition.

The practical section is good, containing many useful hints and few slips. The illustrations are well chosen and produced, and really illustrate the points to which they refer. The type is large and the finish excellent, combining with the pleasing style to make the book agreeable to read. A. D. B.

Algebra
A Text-Book of Determinants, Matrices and Algebraic Forms. By W. L. Ferrar. Pp. vii+202. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 12*s.* 6*d.* net.

THIS is a text-book intended primarily for undergraduates. It is designed to give a broad basis of knowledge comprising such theories and theorems in those parts of algebra which are mentioned in the title as are of constant application in other branches of mathematics.

The book is divided into three parts: namely, determinants, matrices, and linear and quadratic forms. It will be seen at once that there are notable omissions from the usual conception of a text-book on algebra, but the author states in the preface that these omissions are deliberate.

The arrangement of the text rather resembles a geometry in its orderly array of definitions and numbered theorems, but it must be confessed that a decimal numeration of theorems to correspond with that of the paragraphs would have greatly facilitated reference. Although the treatment throughout makes pleasant and easy reading, the author is to be particularly congratulated on his exposition of matrices, which provides just what is greatly needed in many current applications.

There are numerous and well-chosen exercises, with occasional hints, and suggestions for further reading to build on the foundations so ably laid in this book.

SCIENCE AND TECHNOLOGICAL ADVANCE

TO cover effectively the wide field of technological advance, almost all of which is closely bound up with corresponding developments in science, was certainly beyond the aim of the Conference on Science and World Order held during September 26–28. As it was, the papers presented covered a wide and varied field.

Sir Harold Hartley, chairman of the Fuel Research Board, claimed that most of the scientific discoveries of the last two hundred years could not have made an effective contribution to the progress of civilization without the successive technological developments that have made energy available. The main results of this progressive utilization of energy were: (1) Power-driven machines with a continuous increase in the productivity of labour and material resources, first in industry and later in agriculture. (2) Means of rapid transport by land, sea and air, facilitating the development of new countries, making available the world resources of raw materials and food, and providing new markets for industry. (3) Development of metallurgical and chemical industries, producing secondary raw materials for industry and fertilizers for agriculture. (4) The high-voltage distribution of electricity, making possible the dispersal of industry and thus avoiding the over-crowding of urban areas.

Following on these has come another no less far-reaching revolution—the domestic—which has done so much to raise the standard of health and comfort in the home, which may be regarded as repayment by the technician of a long overdue debt for social consequences of mechanization of industry in the nineteenth century.

Fundamental research will yield continuing improvements in methods of utilizing fuel, distribution and storage of electricity, uses of power, and in production of substitutes for mineral oil from coal or vegetable products against a possible shortage. The ultimate goal is the utilization of the sun's radiation currently by some photochemical or photo-electric device or engine, to take the place of the solar energy stored in coal and oil.

The problem of energy was also comprehensively treated by Prof. A. C. G. Egerton, of the Imperial College of Science and Technology. To-day, the world makes use of 1,300 million tons of coal, 270 million tons of oil and 55 million tons of natural gas per annum. Only a very small fraction of the solar radiation (1/60,000) is currently utilized in the form of the food produced by plant life, or in the form of hydro-electric power, through the atmospheric mechanism. If ever the vast stores of energy in the make-up of the atoms can be released, controlled and used, another industrial revolution may be expected. Therefore, in preparing for a new world order, it is necessary to have more accurate knowledge of the material resources of the world and particularly the sources of energy and to plan on the basis of that knowledge.

In a paper by Dr. G. Lewi, Dr. O. Eisler and Dr. J. Cisar on "Problems of the Technology of Unutilized or Insufficiently Utilized Raw Materials and Waste Products", the authors stressed the exhaustion of some raw materials, and the war-time wastage of valuable materials. New methods are required for dealing with new raw materials, or those not sufficiently or efficiently exploited. Nitrogen has already been fixed from the air; other materials as abundant, such as clay and sea water, are waiting to be used, the former as a potential source of light metals. Large quantities of magnesium chloride, which is largely a waste product in the manufacture of potash, ought to be a rich source of magnesium.

There are also new possibilities in the use of wood. The problem involves, first, the best and most efficient methods of processing, leaving as little waste products as possible and, secondly, the further optimum utilization of unavoidable by-products hitherto regarded as waste. Of primary importance is avoidance of the wastage of utilization of coal, an improvement being, for example, the use of naphthalene for the increasingly important carbon-black. Attention was also directed to restoring harmony between the production and consumption of natural raw materials and of their synthetic artificially produced substitutes. Progress made during the War in this direction must be perpetuated.

Dr. C. H. Desch, of the Iron and Steel Institute, likewise discussed the conservation of natural resources. He pointed out that the political pledge to accord access to raw materials means international control of such sources after the War. Minerals, including coal and oil, which are the principal sources of power at present, are capital, and assets, once consumed, can never be renewed. While allowance must be made for technical improvements in working leaner ores and in mining at greater depths, it appears that certain minerals, such as oil and tin, are within calculable distance of exhaustion. Estimates vary widely, but copper, tin, gold, and phosphates, at the present rate of production, are believed to have a further life of less than a century. Coal and iron may last for thousands of years, while the estimates for oil

reserves are very conflicting. Little information is available for the sparsely occurring minerals, such as nickel, tungsten, molybdenum and vanadium, which are increasingly essential for high-class steels. In the first quarter of the twentieth century the quantity of ores taken out of the earth was greater than in the whole of previous history (say, six thousand years after copper was first mined), and at the current rate of development, the world production of many minerals doubles itself in 10–20 years.

Dr. L. E. Howlett described "Canada's Optical Industry" as an example of how the State can establish a new industry to fill a gap in its economy and to supply an urgent need. A great amount of the preliminary investigation of the possibilities, needs in materials and personnel were made by officers of the National Research Council. As a result of this extensive work the Department of Munitions and Supply established an entirely Government-owned company—Research Enterprises, Ltd.—which is charged with the responsibility of producing manifold types of optical instruments required for military, naval and air operations. Although this company is under the responsibility of a different ministry of the Crown from the National Research Council, the resources for research and development and technical counsel which the National Research Council can provide are always at its disposal.

"Science and Technological Advance Applied to Building", was the title of the paper presented by Mr. R. Fitzmaurice, of the Building Research Station He explained why building tends to lag behind other industries in the use that it makes of scientific advances. In the last twenty years, however, much has been done in establishing basic scientific principles which govern building problems. Of principal importance are: the acoustics of buildings, heating and ventilation, daylight illumination, and the exclusion of dampness. Auditoria no longer need result in unintelligible speech, and refinements in design are alone required to reveal the full tonal balance of an orchestra. Technically, local and external noises can be reduced below nuisance values. The cost entailed in these problems has been materially reduced by a proper study of conditions.

More exact control of the usage of fuel has directed attention to provision of heat and ventilation, with greater comfort to the users. The principles underlying the transfer of water in porous parts of buildings have been elucidated, and there is no longer any justification for dampness in buildings.

To apply this knowledge more rapidly, greater emphasis might be given to elementary science in the training of workers in the building industry, including architects, builders, craftsmen and surveyors.

In a paper on "Some Recent Applications of the Theory of Elastic Dislocations", Prof. Enrico Volterra, of King's College, Cambridge, described concrete structures as an example of the utilization to a maximum degree of the resistance of the material employed in building. This was achieved by a study of the conditions of elastic-plastic equilibrium, and of pre-stressing structures. The first study increases knowledge of the state of stresses and deformation of structures when the elastic limit of the material is passed, which then becomes the plastic condition. The second study enables stresses favourable to its stability to be established within the structure. The combined study is called the theory of elastic dislocations, and is the result of the blending of science and technology upon which progress in civil engineering is based.

"Technical Advances in Biology" formed the subject of a discourse by Dr. C. H. Waddington, of the Strangeways Laboratory, Cambridge. Dr. Waddington dealt mainly with agriculture, although medical advances were touched on, such as the alleviation of malnutrition, the conquest of tropical diseases, and the reversal of the falling reproductive-rate, the latter being a political rather than a technical medical matter. Great changes in the production of plant products will probably be brought about; tank culture, with or without artificial lighting, is likely to spread. The control of hormones affecting the growth of particular organs is still comparatively new. Vernalization, in the U.S.S.R., has led to adjustment of the latency, growth and flowering of plants to climatic conditions. There have been spectacular results in utilizing hybrid vigour in maize, and this technique will probably spread to other crops, such as tomatoes. The wealth of new wild forms which have recently been placed at the plant breeder's disposal will make practicable the extension of the zones in which certain flowers flourish. The importance of extending the potato to the tropics and the arctic can scarcely be over-estimated. The recently acquired control over the production of tetraploids, both pure-bred and hybrids, by means of drugs such as colchicine, can scarcely fail to produce entirely novel crop-plants of importance.

The improvement of productivity in animals has always been more difficult than with plants. Artificial insemination already allows the sperm of a tested male to be used on many more females than otherwise would be possible. A tissue method of keeping testes alive might increase the number indefinitely. Hormonal methods of inducing ovulation have already been used to get two crops of

lambs a year. Methods of producing super-ovulation are also known and, combined with the transplantation of the ova to other females, might enable us to multiply by a considerable factor the offspring of a valuable female. A first step has been taken towards the artificial production of tetraploids in mammals, and the doubling of hybrids cannot be considered technically out of the question. The hormonal control of sex-development may yet play a part in poultry and, perhaps, the dairy industries. Methods of separating female- from male-producing sperms have already had some success and may soon play a large part in the same two industries. The use of growth hormones for inducing giant forms, which might conceivably reproduce themselves true to type, is a possibility which may be realized within a few years.

The greatest technical advance which may be expected shortly is organization. The liaison between advanced institutes for practical and for theoretical biology is much less close in Great Britain than in many of the leading countries, such as Sweden, the U.S.S.R. and the United States. The return of many biologists from war-time tasks to biology will be a suitable time to introduce a well-considered re-organization of the whole scheme of biological teaching and practice, from the primary school to the university. Such a reorganization has been long over-due.

In dealing with industrial research and the universities, Dr. F. H. Boer inquired into the possibilities of promoting a beneficial exchange between science and industry. The application of new scientific discoveries and methods to industry and the consequent furtherance of research, necessitates a very close collaboration between men of science and all those concerned in the application of science, but in most countries collaboration between universities and industrial research laboratories is not close enough. The fear that industry will lose its secrets is one of the main factors, though in practice one finds that many of the so-called secrets are not secrets at all. In some large industrial research laboratories close co-operation between scientific workers and technicians exists, and the scientific workers are in touch with the universities.

Leaders of industrial research laboratories must be scientific men with highly developed technical minds and imaginations, and preferably some of them should hold a semi-official position at a university. Smaller industries should unite to establish and maintain sufficiently large research laboratories; there can be no place for small isolated research laboratories in the future, in Dr. Boer's opinion. The Government should endeavour to bring the smaller industries together, and to induce minorities to accept majority decisions. If industry realizes that its first task is to serve the community, then science will minister to industry unreservedly.

The technological advances of the last few decades, which, as Mr. Ritchie Calder pointed out, amount to a second industrial revolution, have made it incumbent upon scientific men to make certain that these advances are used to the benefit of humanity. The immediate task, in the words of Sir Harold Hartley, is to ensure that in the replanning of the world full use is made of the basic knowledge that science alone can provide, particularly in the fields of nutrition and energy, with all that they imply for the well-being of mankind.

SCIENCE AND WORLD PLANNING

Science and world planning was the subject of one of the sessions of the Conference on Science and World Order, and, in one form or another, planning was implicit in most of the papers presented at the Conference.

The need for planning was stressed by many speakers, and during the discussions on human needs and post-war relief the immediate aim of world planning was clearly stated to be the relief of human suffering and the provision of an adequate standard of life to human beings everywhere. Preparations with this immediate aim in view must be made now.

World planning is not a task to be lightly undertaken or one in which quick results can be expected. As M. Maisky, the Soviet Ambassador, reminded the audience, it took the U.S.S.R. twenty years to reach its present advanced state of planned economy. In his view, the chances of replanning the world are years ahead. He characteristically claimed that the immediate plan for all of us is to win the War. Nevertheless world planning can and must be undertaken, provided we do not lose sight of our immediate objective, that of winning the War, and thus ensuring the opportunity to plan.

Some people object to planning because they fear that it would sacrifice the energizing force of competition. But, as Mr. Maurice Dobb, lecturer in economics in the University of Cambridge,

pointed out, competition to-day is not what Adam Smith and the early economists extolled. We have now monopolistic competition, where the public interest tends to be thwarted rather than asserted, and the economically weak subordinated to the economically strong. This is the alternative with which we have to compare economic planning.

The post-war world will need larger economic units and more economic intercourse between nations. But it will need also the maintenance of full employment and the ending of exploitation of weak nations by strong. This synthesis demands a new regime of international planning. It implies the dominance of the social interest over the sectional, of the common good over individual profit.

The need for a new outlook was also stressed by Lord Hailey when dealing with colonial planning: ". . . a modern world which can combine to control the production of tea or rubber, or tin, or copper, in the interest of an investing public might well find the means of exhibiting a greater solidarity in dealing with issues vital to the welfare of Colonial peoples."

Mr. M. Wynants, of the Belgian Commission for the study of post-war problems, who spoke on town planning, was one of the few who attempted to look at the problem of world planning as a whole. He pointed out that the post-war world will be very different from the world we knew, and therefore we must face without delay the need for drastic solutions to the political, economic, social and moral problems. These are aspects of one and the same reality, and it is impossible to propose a solution in one of these fields without automatically bringing about corresponding reactions in the others.

Among the tasks mentioned by Mr. Wynants that can be satisfactorily accomplished only by international planning are: access to raw materials, development of backward areas, public works of an international character, human migration. A solution to these problems will be dependent upon a corresponding organization of political relations.

Town and country planning—according to Prof. William Holford, of the University of Liverpool—is chiefly concerned with the use of land for a variety of human purposes which may be broadly grouped as (*a*) agriculture and forestry, (*b*) development, including industry, (*c*) recreation and (*d*) transport.

The problems of agriculture were outlined by Sir John Russell, director of the Rothamsted Experimental Station. The agricultural systems of pre-scientific days, he stated, had two features in common: they aimed at providing complete subsistence for the community, and at conserving the land. The three-field or strip system common in Great Britain, round the Baltic, in northern India and elsewhere aimed further at an equitable distribution of good and bad land.

As practised in Europe, the strip system had the merit of permanence but was of low productiveness and had to be abolished. The U.S.S.R. adopted one method and Poland another, but a change was essential. In Great Britain the change to unified holdings was made before the scientific era, and technical improvements raised the output per man higher than in any country in Europe, though the output per acre was less than in the smaller western countries of small holdings. In the new economic system introduced since the War, under which specified prices will be received and specified wages must be paid, and with the help of scientific methods, the indications are that high output per acre will be attained, as well as high output per man (see also NATURE, of October 18, p. 456).

The dangers of deforestation were touched upon in a paper prepared by Lord Onslow, who made an appeal for the conservation of the wild life of the world. Within the last hundred years or so, several dozen species of animals of æsthetic, scientific and commercial value have been exterminated, and it is of the utmost importance to save others from a similar fate.

"Free play given to economic forces in the past has led to localization of a single industry in one district and has resulted in derelict areas and 'ghost towns' when that industry was depressed", stated Prof. P. Sargant Florence, of the University of Birmingham. Recent scientific progress has on the whole intensified the economic trend towards industrial concentration; if the social and socio-economic criteria are accepted and dispersion of industry is adopted as a policy, hard thinking and fighting lies ahead for planners.

Dr. Othmar Ziegler, lately of the University of Prague, dealt with the transport problems of the Danube States, and estimated that if transport can contribute to raising the standard of life in south-eastern Europe to one third or one half of that of western Europe it will furnish employment, through the expected increase in exports, to tens of thousands of workmen in western Europe.

The world's heat and power requirements was the subject of a paper by Sir Harold Hartley, who pleaded for a detailed consideration of the world's energy resources, their utilization and conservation, in the light of post-war schemes of reconstruction. If all the potential water resources were to be harnessed, the estimated energy would not exceed 30 per cent of the requirements, so that burning of fuel must continue to supply the greater part of the world's energy consumption until some other source, such as the direct utilization of the

sun's radiation, has been made practicable upon a large scale.

Carbonization of raw coal and the use of electricity in a co-ordinated scheme, designed to secure maximum advantages from both, will help to solve the problem of smokeless cities and provide cheap energy needed in homes. Wider application of energy on farms, and in conditioned transport and storage, would increase productivity and accelerate processing. With the scientific knowledge we now possess it should be possible to plan with much greater certainty than in the past.

Dr. Ove N. Arup, a civil engineer from Copenhagen, inquired into the reasons why modern buildings lack many of the desirable qualities which modern science and technique have made possible : warm, sound-proof rooms, well ventilated and provided with labour-saving devices. The difficulty appears to lie in specialization, and Dr. Arup asked whether a "composite mind" could be created in the form of an organization that would achieve a well-balanced synthesis from the wealth of material available. There exist already teams which include architects, engineers, heating specialists, etc., but so long as such groups work for profit they may try to keep their experience secret or advocate materials and processes in which they have interests. An extension of the present research stations is needed, to carry out the checking up and classification of existing technical information, and the creation of planning organizations.

The nature of modern science demands not only planning and team work, stated Mr. D. P. Riley, of the University of Oxford, but also international planning and team work. To overcome the language difficulty a co-ordinated system of abstracting would be very valuable. More frequent international conferences should be held and their scope should be enlarged so that, with a modified organization of conference procedure, they may become valuable world-planning commissions.

Prof. Jacques Metadier, formerly professor of biological physics in the University of Poitiers, advocated the setting up of an international society for scientific research, a kind of co-operative society to which everyone concerned in the exploitation of scientific discoveries would have to contribute a small percentage of their profits. Out of the resulting fund payments would be made to scientific workers whose researches had been economically exploited, and, in addition, research scholarships would be created and pensions would be made available to research workers over a given age, even though their labours may not have had practical applications.

Turning from visions of what the future might bring, to research now being carried out relating to planning and to post-war reconstruction, Prof. Alvin H. Hansen, of Harvard University, gave an outline of what is being done in the United States. For the last eight years the National Resources Planning Board has been engaged in studies relating to the natural, human, scientific and economic resources of the nation. Some of its activities in connexion with social welfare have already been noted (see p. 455). In addition, the Board is required to maintain a six-year programme of Federal Public Works.

In 1934 the Board sponsored a survey of the extent of soil erosion, which led to the establishment of the Federal Soil Conservation Service with authority to make surveys, conduct research, establish demonstrations and educate the public about soil conservation. In 1936 the new Agricultural Adjustment Act combined the dual purpose of soil conservation and agricultural production, and the Flood Control Act charged the Department of Agriculture with responsibility for watershed treatment.

One of the most significant achievements of the United States Government during the past ten years has been the redevelopment of the Tennessee Valley, with an area nearly as large as Great Britain. The large-scale planning carried out by the Tennessee Valley Authority was described by Prof. L. Gulick (see p. 388). Planning, said Prof. Gulick, is not only compatible with a democratic system of multiple parties, free elections, free criticism, free discussion, free enterprise and private capitalism, but it is essential in releasing the energies of freely co-operating individuals and governmental and private corporations in fulfilment of plans and objectives.

Mr. Hugh P. Vowles, on the other hand, who has made a study of large-scale electrification in several countries, considers that scientific planning upon a comprehensive scale is incompatible with private capitalism. There can be no co-ordinated development of power and associated resources, since one authority would plan electrification and another gas supply without pausing to consider whether they fit together, or with other associated activities. In the Soviet Union, he claimed, co-ordinated planning covers all aspects of exploitation of power and material resources, with the public welfare kept steadily in view.

This ends the series of summaries of deliberations of the Conference. In this, and in the previous five reviews, an attempt has been made to bring together pronouncements bearing upon specific subjects, so as to form a consecutive whole. Unfortunately, the contributions considered, though generally good in their particular field, frequently bore little relation to one another ; they will serve excellently, however, as material for a future conference on world planning.

SCIENCE IN THE DEFENCE OF CIVILIZATION

RADIO MEETING AT MOSCOW

WORLD-WIDE interest and sympathy has been aroused by the appeal of the meeting of men of science held in Moscow on October 12. Messages of greeting, sent in advance to the meeting, included one from Sir Henry Dale, president of the Royal Society of London, declaring solidarity with the Soviet men of science and those of the whole world who are united in the struggle against Germany's attack on freedom, including free scientific research.

The Secretaries of the Royal Society also sent messages declaring that Russian men of science are fighting for all that is essential for the development of science, and that their great achievements in science will serve as a firm support in this struggle.

In the name of forty thousand members, the secretary of the British Medical Association sent greetings to the representatives of medical science in the Soviet Union, and wishing success in the common task of freeing humanity from its sufferings in a new, better world which will be built after the War.

Other messages were sent including greetings from Sir Richard Gregory, president of the British Association, Prof. Julian Huxley and Prof. J. B. S. Haldane and Mr. and Mrs. Sydney Webb. Many messages were sent from the United States, including those from the president of Harvard University, representatives of Columbia University, the Universities of Chicago and New York and from many other American men of science.

The Association of Scientific Workers, in its message, welcomed the timely action of Soviet men of science in organizing the meeting. Its message concluded: "We British scientists deeply appreciate that our Soviet colleagues are right in the front-line of the struggle against Fascism, and we send them our warmest greetings. We feel that world-wide contact between scientific workers, in order to exchange information, ideas and technique, will be an important factor in ensuring victory. In particular, the closest collaboration must be created between Soviet, American and British scientists. We represent between us a free intellectual power which Hitler cannot emulate. Let us make certain that it is used to the full to win the war and create a better world. Our Association is organising a Conference in January to discuss in detail how we, as scientists, can increase production, protect the people's health, and train reserves of technicians. Let us hear from your scientists all over the world how you tackle these problems."

Prof. V. L. Komarov, president of the Academy of Sciences of the U.S.S.R., was prevented by indisposition from attending the meeting. He sent the following message: "Brothers in the common cause, scientists of the world, creators of culture and progress, this is a decisive and momentous hour for humanity.

"The sinister hordes of modern vandals are holding out a mortal threat to world civilization. The mightiest democracies of modern times, together with all freedom-loving peoples, are mobilizing their forces against the enemy of mankind. Part of the arsenal of the anti-Fascist coalition is the unlimited creative power of science.

"The scientists of the Soviet Union are ardently taking their share in promoting the industrial, cultural and military progress of their country. The knowledge of danger multiplies our strength and will to victory. Throughout the vast expanse of their country, Soviet scientists are seeking new sources of raw material and power, developing new technological methods and designing new plant with the purpose of expediting victory.

"Soviet scientists appeal to the science of the world to aid the greatest and most worthy cause of modern times. We appeal for the union of all forces for the utter defeat of Fascist Germany. The time is short; decisive days have come. The future of mankind, its progress and plans demand the annihilation of the reactionary Hitlerite clique."

Prof. Butyagin, who took the place of Prof. Komarov, said: "Hitler is the enemy of science, progress and enlightenment. He has destroyed culture in France, Holland and the Slavonic and other countries which he has occupied. Hitler seeks to suppress culture and science all over the world. Therefore it is our task to fight for the liberty of humanity. The scientists of the Soviet Union are taking a whole-hearted part in the industrial, cultural and military development of the country. Soviet science has been responsible for great achievements, for the translation of the scientific literature of various nationalities, for new development in many fields."

Prof. P. Kapitza, who was formerly Royal Society Messel research professor and director of the Royal Society Mond Laboratory, and is well known for his work in magnetism and low-temperature research, pointed out that in the past twenty years military technique has made great strides, and there is no doubt that, with the present level of knowledge, it may make greater strides still. Fascism employs science solely for

the purposes of war. The task to-day is to eradicate Fascism, which has already caused so much misery and destruction all over Europe. The scientific resources of the democratic countries are considerably larger than those of Nazi Germany. Under the ægis of Nazism, the level of even the exact sciences has declined frightfully in Germany, and partly for this reason German technique has already begun to lag behind in many respects.

Science has not exhausted its potentialities of combating the aggressor. Consequently, if other men of science join their efforts to those of the U.S.S.R., the enemy will be defeated all the sooner, and the menace threatening the world will be averted.

Prof. T. O. Lysenko, well known for his work on the process of vernalization of seed, said that true science directs its creative efforts to the discovery of the laws of Nature, to mastering and directing these laws for the benefit of social welfare. On the basis of the teachings of Charles Darwin, Soviet men of science have achieved advances in the planned alteration of the nature of plants important for agriculture. They have created remarkable new varieties of plants and animals.

Present-day German men of science pervert and defile biological science. The Nazi racists distort biological science in order to give a so-called 'scientific basis' for the Nazi theory of higher and lower races, for the ruthless extermination of millions of people.

Scientific discoveries can improve the living conditions on this earth. Bloodthirsty Nazism, however, does not set itself the aim of making life happier and easier by conquering the forces of Nature for the service of man, as can be done through the medium of science. Its aim is to devastate the earth by robbery and violation.

The true men of science, biologists of the United States, Great Britain, the Soviet Union, who respect humanity and its creations, do not defile the science of biology, do not use it in order to enslave humanity. With their scientific work, they help humanity to make better and better use of natural resources . Modern science is inseparable from democracy, and we must do our part in liberating humanity from Fascist tyranny.

Prof. A. E. Fersman described the Soviet Union as a country stretching from polar islands to the tropics, reaching heights of more than seven and a half kilometres, and with valleys lying hundreds of metres below the sea-level, with deserts and stretches of land of permanent frost and ice, of more than ten million square kilometres, a vast country inhabited by the greatest variety of nations, speaking a hundred and fifty different languages, with their national cultures, habits and ways.

For many years it was desolate and unexplored. More than half of it had never been investigated by geologists or geographers. Only fourteen kinds of metals out of the ninety elements of the Mendeléeff table were extracted from its earth. The plants of its tropics were growing wild.

But the country has risen to new heights during the last twenty years. Tens of thousands of scientific expeditions have carefully explored its unknown parts. During this last quarter of a century, the first geological map of the U.S.S.R. was made, and during these years about 75,000 new fields where useful ores could be extracted were found. The amount of coal resources known increased ten times, that of iron ore thirty-three times, copper and lead more than ten times. Many of these ores have never been extracted before. Mendeléeff's table has been practically covered by the variety of our extractions.

The rich soil, too, was explored. Agriculture developed all over the country, in the north, in the deserts of middle Asia. A new geography was started in the country. A network of railway lines was covering it—connecting the industrial centres with the far-away southern Urals, the heights of the Altai, the rough forest district of the Pechora. It was a grand picture of peaceful labour, transforming the earth by human reason and scientific work.

Now this work of conquering the forces of Nature has been crudely interrupted by the wild aggression of barbarism. Soviet science has switched over, and turned its powerful knowledge wider, fuller still for the protection of the Soviet country. War not only requires more raw materials. It also requires thousands of new materials for defence work. It opens up a wide field of activity to all geologists and other men of science. Then, when Fascism is smashed, science will again return to its peaceful course, and will place the fruits of its labour at the disposal of a liberated world.

Prof. A. N. Frumkin spoke in the name of all Soviet chemists. Among the weapons with which Fascist Germany is attempting to strengthen the legend of its invincibility, an important part is played by the high level of German chemistry. Without doubt, the development of chemistry and chemical industry are among the most essential factors on which modern warfare depends. At the beginning of the War of 1914–18, Germany occupied undoubtedly the first place in chemical industry, the high level of which helped her to a great extent to overcome the difficulties caused by the blockade. However, in spite of such great achievements as the development of the production of synthetic ammonia, etc., the chemical industry in Germany was unable to avert the exhaustion of its resources and the final collapse.

In the period after the War, there was a strong development of chemical industry in the United States on the basis of the oil industry. Apart from this, the achievements of German chemical industry were largely due to the high level of scientific research. This basis of scientific research was broken up by the decline of German science when Nazism came to power.

In the period between the War of 1914–18 and this War, German chemical industry, which was then on a technical level much superior to that of Tsarist Russia, was developed. In spite of this, we can be sure that if chemistry was unable to save Germany in the War of 1914–18 it is still less able to save it now. The Soviet chemists have been able to evolve a number of new and important methods of production. At the present moment, they are mobilizing all their strength to help in the struggle against Fascism. The Soviet chemists will collaborate with the men of science in Great Britain and the United States who signed the appeal to fight Fascism.

Prof. Frumkin called on men of science throughout the world to use their knowledge for the invention of new methods in the fight against Fascism. In the face of the Fascist attack there can be no place for 'science for the sake of science', for 'science which must remain neutral'.

The Soviet men of science then issued an appeal to all men of science, the substance of which was as follows: "Soviet scientists gathered at the Anti-Fascist meeting in Moscow appeal to scientists of the whole world to unite their forces against Hitlerism, the greatest enemy of culture and science. By participating in the war of our country against Fascism we are endeavouring not only to do everything within our power to expel from our territory the Fascists who have been inflicting unheard of and bestial tortures on our citizens, but also to help in establishing a democratic life for all peoples and to come to the aid of science and culture now threatened by Fascism. This menace of Fascism hanging over the whole world seeks to destroy freedom, civilization and all scientific progress.

Hitler's vandals have closed down the centres of culture in the countries which they have occupied. Universities and schools have been closed in Belgium, Norway, Holland, Latvia, Lithuania, Poland, Yugoslavia, Greece and Czechoslovakia. Fascist reaction has stifled scientific thought in France. Fascism has defiled science. In the place of the power of reason the Fascists have proclaimed the power of brute force, ignorance and base instincts. In place of biology, the majestic science of the laws of life, the Fascists invented their inhuman racial theory, with the object of justifying their domination of the whole world. For sciences which foster greater unity among peoples and better mutual understanding, such as geography, ethnography and history, Fascism has substituted so-called geo-politics, with the sole aim of justifying Germany's right to predatory invasion and the enslavement of other peoples. Fascism has replaced the humanism characteristic of the spiritual development of peoples by the creed of eternal war and progressive marasmus, by depravity, the enthronement of darkest reaction and the mass murder of the weak, the old and the infirm. Fascism is a deadly menace to culture and science which are most dear and precious to us. In their common work for the conquest of Nature, scientists throughout the world pay the greatest attention to the furtherance of culture and the welfare of the human race, whereas Fascism utilizes the achievements of modern science and its technique for destruction and extermination.

"Our scientific work has always been closely related to the requirements of the peoples of our country, which coincide with the interests of the whole of humanity. Our scientists have always put their work at the disposal of our country in making available its immense natural resources and developing its national economy. The scientific development of our national economy permitted the creation in twenty years of large-scale industry and a reorganized agriculture, which has increased the standard of living of all the peoples of the Soviet Union.

"Our country grew in strength as a result of the collaboration of all the nationalities inhabiting the Soviet Union. By the laws of our constitution all nationalities have equal rights and are equally respected as members of our large Soviet family. Our scientists study the history of all peoples of the Soviet Union, study their folk-lore and enrich Russian national culture. This work has fostered the unity of our people and their mutual respect for each other's culture.

"We Soviet scientists are convinced of the final victory over Fascism and its complete annihilation. We consider that the mutual understanding and respect of all nations, based on equality and the independent culture of each country, is the basis for their collaboration.

"We appeal to the scientists of the whole world at a time when the Soviet people have to bear the brunt of Hitler's war machine, when our towns are being destroyed and our people subjected to plunder and torture, at a time when the question of the existence and liberty of the peoples of the Soviet Union, Great Britain and the United States are being fought out on our battle-fields.

"All people interested in culture and science must unite to prevent Hitler from destroying the nations one by one."

ACTIVITY OF CARBONIC ANHYDRASE WITHIN RED BLOOD CORPUSCLES

By Prof. D. Keilin, F.R.S., and Dr. T. Mann
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CARBONIC anhydrase, the enzyme which catalyses the reversible reaction $H_2CO_3 \rightleftharpoons CO_2 + H_2O$, is present in a large concentration in the red blood corpuscles[1], the gastric mucosa[2,3,4] and the pancreas[5] of vertebrates, especially mammals. The enzyme plays a very important part in the carbon dioxide transport by the blood, and its activity is directly or indirectly linked with the reactions involved in the acid-base equilibrium in the body.

It was shown recently that carbonic anhydrase is a zinc-protein compound where zinc forms the active part of the enzyme molecule[6,7]. Although carbonic anhydrase is present in mammalian erythrocytes in a very large concentration (namely, 0·21 gm. of pure enzyme per 100 c.c. of erythrocytes) the activity of this enzyme cannot be detected on intact blood cells by applying to them the standard manometric or colorimetric methods. In fact, the entire study of this enzyme, including that of the kinetics of the reactions it catalyses, has so far been carried out either on laked blood or on hæmoglobin-free enzyme preparations[1,7,16]. On the other hand, the small activity exhibited by the corpuscles in manometric experiments carried out under certain conditions[8] cannot definitely be ascribed to this enzyme as no control experiments were done under precisely the same conditions on corpuscles treated with one of the inhibitors of carbonic anhydrase.

In the present article we propose to describe a simple spectroscopic method by means of which the catalytic activity of carbonic anhydrase within the corpuscles can be easily demonstrated and studied quantitatively. This method is based upon the following facts:

(1) Hæmoglobin within the red blood corpuscles can easily be oxidized to methæmoglobin without affecting the integrity of the cell walls.

(2) Methæmoglobin can act as an indicator[9,10] changing its colour and the pattern of its absorption spectrum with the change of pH from 6·5 to 9·5.

(3) The change from acid to alkaline methæmoglobin within the corpuscles can easily be observed[11] by treating them with alkaline phosphate or carbonate solutions. The reverse reaction can be seen by treating the alkaline cells with carbon dioxide or acid phosphate solution.

(4) The velocity of these changes can be determined spectroscopically with great precision.

(5) Carbonic anhydrase is strongly and reversibly inhibited by sulphanilamide[12] which rapidly penetrates within the corpuscles and which, unlike other inhibitors of carbonic anhydrase (such as potassium cyanide, hydrogen sulphide and sodium azide) does not react with methæmoglobin.

The catalytic activity of carbonic anhydrase within the corpuscles can, therefore, be determined by comparing the velocity of the changes from acid to alkaline methæmoglobin and *vice versa* in presence and in absence of sulphanilamide.

Preparation of Methæmoglobin Corpuscles

The red blood corpuscles of 100 c.c. of defibrinated horse blood separated from serum are washed with 0·9 per cent sodium chloride. 50 c.c. of washed corpuscles are mixed with an equal volume of isotonic solution of sodium nitrite (1·06 per cent), left standing five minutes, washed four times in 200 c.c. of 0·9 per cent sodium chloride and suspended in 100 c.c. 0·9 per cent sodium chloride. The suspension A thus obtained is composed of brown cells showing a distinct absorption spectrum of acid methæmoglobin.

On addition of alkaline phosphate or of carbonate solution to this suspension its colour turns from brown to red and the absorption spectrum of acid methæmoglobin is gradually replaced by that of alkaline methæmoglobin.

Spectroscopic Study of Methæmoglobin Corpuscles.

The changes in the absorption spectra of these corpuscles were followed at 17° by a method devised previously for the study of methæmoglobin[13], the observations being carried out by means of a microspectroscope ocular attached to a microscope (Fig. 1). 2·5 c.c. of suspension A are mixed with 150 c.c. 0·9 per cent sodium chloride forming a dilute suspension B. 3 c.c. of B are put in the flat-bottom vessel g 16 mm. in diameter immersed in a small glass water-bath h placed on the microscope stage. The depth of suspension in g is therefore $\frac{3}{3 \cdot 14 \times 0 \cdot 8^2} = 1 \cdot 5$ cm. The standard suspensions of acid and alkaline methæmoglobin corpuscles are introduced into compartments e_1 and e_2 of a double-wedge trough 15 cm. long and 2·3 cm. wide (inside measurements). These suspensions

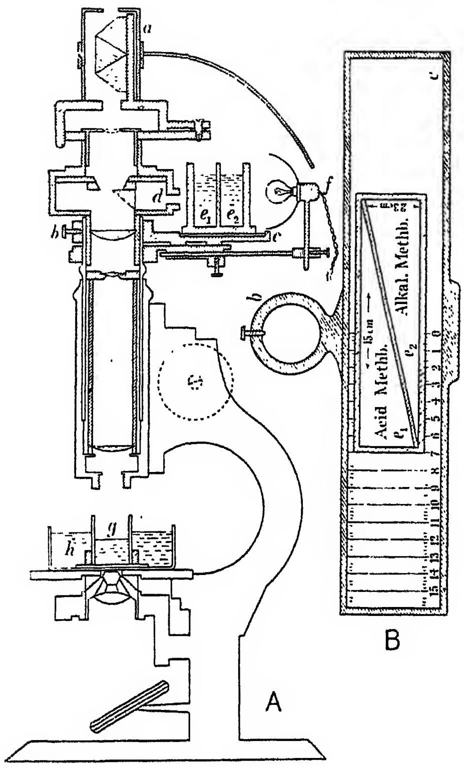

Fig. 1.

are prepared in such a way that in a depth of 2·3 cm. they match completely the 1·5 cm.-deep suspension of vessel g. For this purpose 1·63 c.c. of stock A is suspended in 120 c.c. 0·9 per cent sodium chloride forming stock C; to 60 c.c. of this suspension is added 15 c.c. of $M/5$ phosphate solution of pH 6·4 forming the suspension for the side e_1 of the trough, to the remaining 60 c.c. of stock C is added 15 c.c. of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide solution forming the suspension for the side e_2 of the trough. The trough is placed in front of the side aperture d of the micro-spectroscope on a brass platform c attached by means of a ring b to the microscope tube. The position of the trough is read on a scale fixed to the platform and covered by a sheet of glass along which the trough can be easily moved. The vessel g is illuminated in the usual way, while the trough is illuminated by a 4-volt filament lamp f. The intensities of both lamps can be regulated by means of independent rheostats. While keeping the illumination of the two spectra equal by adjusting the rheostats, the trough is moved along the platform until the position is found where the intensities of the absorption bands of the spectra obtained from the suspension in g and from that in the trough are equal. At the beginning of the experiment the suspension in vessel g received 0·1 c.c. of $M/5$ phosphate solution pH 6·4 and the position of the trough is adjusted and read on the scale. The vessel g then received 0·1 c.c. $M/5$ sodium carbonate which is rapidly and thoroughly mixed with the suspension of corpuscles. The trough is moved along the platform towards the left and its positions at which both spectra match are read from the scale at intervals of 10, 15, 20 seconds or longer if necessary. The percentage of alkaline methæmoglobin formed is obtained by multiplying the reading (in centimetres) of the scale by 100/15. Thus if the reading is 6·5 cm. the alkaline methæmoglobin formed will be 43·2 per cent.

Concentration of sulphanilamide	Time for 50% change (sec.)
0	34
$5 \times 10^{-6} M$	52
$5 \times 10^{-5} M$	75
$5 \times 10^{-4} M$	210

The experiments described above were followed by others in which a small amount of sulphanilamide ($5 \times 10^{-4} M$ final concentration) was added to suspension g one or two minutes before the addition of carbonate. The results of a typical experiment in presence and in absence of sulphanilamide, which are shown in Fig. 2, clearly demonstrate the catalytic activity of carbonic anhydrase within the red blood corpulscles. The effect of other concentrations of sulphanilamide which was determined by the time (in seconds), required for 50 per cent change is shown in the accompanying table.

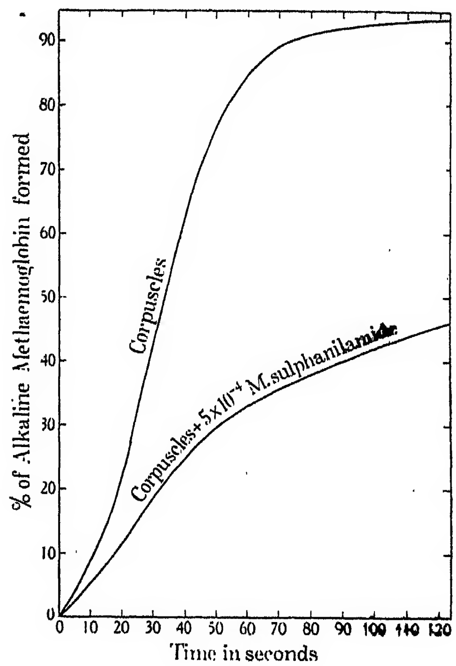

Fig. 2.

That no laking takes place during all the experiments described in this article is clearly demonstrated by the colourless supernatant fluid left after centrifuging off the corpuscles in suspensions *g*.

Chloride Shift

The method described above affords also an easy approach to the study of Hamburger's chloride shift. It is well known that the red blood corpuscle is impermeable to metallic cations, so that when, for example, bicarbonate ions move into or out of the corpuscle, the ionic equilibrium on both sides of the membrane is re-established by the movement of chloride ions in the opposite direction, which is in accordance with Donnan's membrane equilibrium theory[14,15,16,8]. The available chloride ions in the corpuscle may therefore become the limiting factor in determining the amount of another anion which can pass through the membrane[16]. On the other hand the concentration of the chloride ions in the corpuscles can be greatly reduced by washing them in an isotonic phosphate solution[8]. It is, however, important to note that washing the corpuscles in acid phosphate makes them impermeable also to anions. Thus, acid methæmoglobin in such corpuscles does not turn alkaline even after prolonged incubation in an isotonic mixture of sodium chloride and sodium carbonate and yet on plasmolysis methæmoglobin becomes completely alkaline. The simplest way for removing chloride ion from corpuscles without affecting their permeability is to wash them in an isotonic alkaline phosphate solution or in a solution of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide. The corpuscles washed in this way and suspended in 12 per cent sucrose solution show about 85 per cent alkaline methæmoglobin. Such corpuscles were used for spectroscopic experiments carried out as above, except that acid phosphate is now added to alkaline corpuscles and the velocity of the formation of acid methæmoglobin is recorded. The results of these experiments summarized in Fig. 3 clearly show that the addition of acid phosphate alone produces only a slow and incomplete change from alkaline to acid methæmoglobin. A rapid and complete formation of acid methæmoglobin takes place, however, if together with the same amount of acid phosphate a small amount of sodium chloride is added to these corpuscles. The fact that this rapid reaction is also inhibited by sulphanilamide shows that also the chloride shift depends on the activity of carbonic anhydrase. Cl′ in this reaction can be replaced by Br′ and I′.

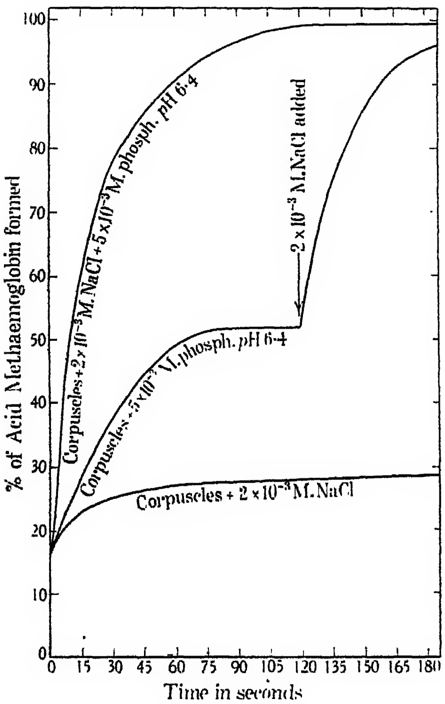

Fig. 3.

The results obtained spectroscopically, which are moreover in agreement with previous views on the subject[8,16], are corroborated by direct estimations of chloride diffusing from the corpuscles into the surrounding medium. For this purpose methæmoglobin corpuscles or untreated red blood corpuscles are washed in 6 per cent glucose solution. 2 c.c. of these corpuscles are suspended in 11 c.c. of isotonic glucose solution, kept for thirty minutes at room temperature and cooled to 0° C. The cold suspension is treated then with 1 c.c. of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide and the corpuscles are rapidly centrifuged within two minutes, leaving 10 c.c. of supernatant fluid *D*. The second sample of 2 c.c. of corpuscles is suspended in 11 c.c. of 6 per cent glucose solution containing 70 mgm. sulphanilamide and then treated in the same way as the previous sample, giving finally 10 c.c. of supernatant fluid *E*. The third 2 c.c. sample of corpuscles is also suspended in 11 c.c. of 6 per cent glucose and, without previous treatment with carbonate, the corpuscles are centrifuged off, leaving 10 c.c. of supernatant fluid *F*. The estimation of chloride in these three fluids, carried out in the usual way[17,18], gave the following results: sample *D* obtained in absence of sulphanilamide contained 2·5 mgm. chloride, sample *E* obtained in presence of sulphanilamide contained only 1·63 mgm. chloride, and the untreated sample *F* contained 0·3 mgm., chloride. While a delay in centrifuging up to fifteen minutes has no effect on samples obtained in the absence of inhibitor, those in presence of sulphanilamide after four and fifteen minutes delay in centrifuging contained respectively 1·9 mgm. and 2·5 mgm. chloride.

All this clearly shows that sulphanilamide, as would be expected, delays the reactions which induce the 'chloride shift'.

The main results of our investigation consist, therefore, in the direct spectroscopic demonstration: (a) of the activity of carbonic anhydrase within red blood corpuscles, and (b) of the link between this activity and the chloride shift which forms part of the mechanism controlling the acid-base equilibrium in blood.

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OBITUARIES

Mr. A. H. Smith, C.B., F.B.A.

MR. ARTHUR HAMILTON SMITH, who died on September 27, was best known among classical scholars and archæologists by his Catalogues of Classical Sculptures and of Engraved Gems in the British Museum, but in unobtrusive ways he rendered valuable service to ancient art and archæology.

He was born near Glasgow on October 2, 1860, the son of Mr. Archibald Smith. He was a scholar of Winchester College and of Trinity College, Cambridge. In the Classical Tripos Part II he was placed in the first class in 1883. In 1886 he entered the British Museum as an assistant in the Department of Greek and Roman Antiquities, at a time when the great reorganization initiated by Sir Charles Newton had reached the stage at which the antiquities could be catalogued and described. To Arthur Smith were assigned the "Catalogue of Engraved Gems" (1888), a modest but very useful book, and the "Catalogue of Sculpture" in three volumes and on a more extensive scale, which occupied the greater part of his years of museum service. He also wrote the popular "Guide to the Department of Greek and Roman Antiquities" to which many owe their first introduction to ancient art in general. Unofficial but closely related to his departmental work was his editing of the first two fascicules of the "Corpus Vasorum" for Great Britain, an early contribution to a vast project, of French origin, which needed judgment and industry such as his in its first rather experimental stages. He had already contributed in an unusual and interesting way by devising a 'cyclograph' in which a cylindrical or conical object was carried forward along the circumference of a circle, and at the same time rotated in front of a photographic camera at the centre, so that a record of its curved surface was made on a flat print. The procedure was that of the rotary printing press; though unless the surface was approximately cylindrical there was distortion, and if it was convex in a second direction there was loss of focus also. To demonstrate his invention Smith published a series of "White Athenian Vases in the British Museum" with collotype plates; but the device has not been much used, though it was awarded a gold medal at the Berlin Photographic Exhibition in 1896.

Smith's learning and sound judgment were well employed on the catalogues of the Lansdowne, Yarborough, and Woburn Abbey Collections, where there was a good deal to add to the pioneer descriptions of Michaelis. He wrote a historical account of "Lord Elgin and his Collection", and a critical study of the "Sculptures of the Parthenon".

Most of Smith's work was naturally in London, but when the Turner Bequest enabled the British Museum to make excavations in Cyprus, Smith was for a while in charge at Amathus in 1893–94, and at Enkomi near Salamis in 1896, and he took his share in the publication of the finds (1899). But these lay outside his special interests, and for Enkomi there was the further drawback of the preposterous chronology favoured by his chief.

In 1909 Smith became keeper of his Department, and on retirement in 1925 received the C.B. He was a fellow of the British Academy, and of the Society of Antiquaries, president of the Hellenic Society, 1924–29, and for long the editor of its *Journal*. For many years he was treasurer of the British School of Archæology in Rome, and chairman of its Faculty of Archæology, History, and Letters. In 1928–30 he went to Rome as its director, and returned in an emergency in 1932. His administrative experience and sound knowledge of his own subject were invaluable here, but he had little experience of students or academic life. Another external interest was in Byzantine art, and he was one of the founders and managers of the Byzantine Research Fund, later administered by the British School at Athens.

His unassuming manner and hesitancy of utterance did not conceal his kindly and humorous outlook on men and things, and his knowledge and judgment were always at the disposal of others.

JOHN L. MYRES.

WE regret to announce the death of Prof. R. B. Wild, emeritus professor of materia medica and therapeutics in the University of Manchester, aged seventy-nine.

NEWS AND VIEWS

The Prospect Before Us

On p. 477 of this issue appears an argument which attempts to explain the behaviour of present-day Germany. On p. 490 are published extensive abstracts from the messages sent by Russian men of science to others in democratic countries. These messages constitute first a direct appeal to all decent men; but they go farther than that. They tell of the progress of science in post-revolutionary Russia. As shown in an article on "The Rise of Science in Russia" (Nature, September 27, p. 357), science in that country was initiated chiefly by men invited for the purpose from other more progressive countries. Science of the past quarter of a century in the U.S.S.R. has been developed by her own sons, as shown in the two articles "Present-Day Science and Technology in the U.S.S.R." and "Biological Science in the U.S.S.R." (Nature, September 27, pp. 360 and 362). But one of the faults of modern science in the U.S.S.R. has been its intense nationalism, though that great country has certainly shown signs of veering away from this drawback during the past ten years. The tendency to keep her scientific discoveries to herself has been too evident in the U.S.S.R., so it is no cause for surprise that many other men of science have questioned, even suspected, Russian scientific claims in the recent past. That cause for complaint is, we are glad to see, fast disappearing. For example, glancing through the correspondence columns of Nature over a period of the past ten years, we see an increase in Russian contributions which runs concurrently with a corresponding decrease in contributions from Germany. These naturally inspire the questions: Where is it all leading: what is the prospect before us? Looking back, we must realize that the U.S.S.R. had the despotic Tsarist regime behind it; small wonder that to-day they are 'realists'. On the other hand, present-day Germany with her science in chains has a past of great scientific achievement based on the best traditions.

We might say there are at least three sources of inspiration for a man of science as such—fear, gain, service. Who can doubt that present-day Russian men of science are inspired by service—service to their own country? Nevertheless, we feel that in the past they have kept themselves too much to themselves. Their science has been directed solely to their own needs: as M. Maiski recently stated, Russian science is planned; "there is no place in the U.S.S.R. for pure science"—a rather unfortunate statement, since we do not believe that pure science has been altogether taboo in the U.S.S.R. Nazi German so-called science is, on the other hand, inspired solely by fear or gain—by fear of political or military overlords or by the desire for Nazi favours or personal profit. From the designing of murderous weapons of war to the postulation of absurd racial theories, it is clear that little true science exists in that unhappy country. And all this went on before war broke out—it has been going on since 1933. There has been such complete subjugation of science that what there is left must remain suspect, if not, indeed, the subject of ridicule, such as the Nazi-inspired philosophy of Stark, one of the world's greatest physicists (see Nature, 141, 770; 1938). All this makes the prospect of those concerned for the future of science one of enormous difficulty, fraught with many tough problems, but none of them insurmountable. The vexed question of pure as opposed to applied science will be one which will have to be considered with cool judgment.

Of course there are, and there will be, extremes and extremists. Even now it is often difficult to decide what is pure and what is applied. The period between a scientific discovery and its application to human society must vary within very wide limits. If planning aims at reducing that period to the minimum, then planning is good; but where the period cannot be envisaged at all, as in the more theoretical sciences and philosophies, we must not allow the extreme materialists to eject such branches of science from the programmes of the future. The ultimate prospect must be a thorough study of the impact of science on society. That cannot be undertaken under any form of duress; there must be complete freedom. But the extremes must be brought to book. Those who will look only at such sciences which can show immediate application must broaden their views. On the other hand, there are those who deliberately hold themselves aloof from any effect their science may have on human society; they are, to say the least of it, selfish, though how often has one heard them claim that they are the only champions of scientific freedom. Science, planned but free, must be the ultimate aim. But the immediate aim is more urgent. This is no time for half-measures and compromise; neither is it the time for ideals. The truth is, Russian men of science have appealed for scientific collaboration with the immediate aim of crushing Nazi barbarism. Men of science in all free countries must respond to that call. That aim demands an immediate unity of purpose and action in smashing aggression; the complete unification of world science must be left to times less terrible and urgent, though not necessarily until the end of the War.

Arrest of French Men of Science

On October 19, the Vichy Government confirmed the arrest in Paris by the German authorities of five prominent professors of the University of Paris, namely: Prof. E. Borel, professor of mathematical physics; Prof. P. Langevin, professor of experimental physics in the Collège de France; Prof. L. Lapicque, professor of physiology; Prof. C. Mauguin, professor of mineralogy; Prof. A. Cotton, professor of physics. According to some sources they are

charged with spreading de Gaullist propaganda, according to others with pro-British sentiments, while some newspapers lay emphasis on the fact that the political activity of Profs. Langevin and Borel has been well known since the time of the Front Populaire. Prof. Langevin was imprisoned earlier this year and released later for health reasons.

According to *The Times*, these arrests are causing bewilderment in Haute Savoie, as even the former political opponents of these men of science cannot believe that they have been arrested on account of their personal views. Some light may be thrown on the affair by a recent article published by M. Laval in his newspaper the *Moniteur du Puy-de-Dôme*. In this he says that now that Germany has conquered her enemies, who are those of France, the latter must conquer her disorder and errors and hold out her hand to Germany. Laval then declares that all French persons who are still imbued with anti-German prejudice should be at once dismissed from public offices. He adds that this prejudice now exists, mainly among the intellectuals, where it may be regarded as a remnant of anti-Fascism. In Haute Savoie the view is expressed that the above 'ultimatum' by Laval inspired the Vichy Government to act accordingly, as the French authorities certainly lent a hand in the arrest of the Paris professors.

German Persecutions in Poland

WE have received from the Association of Polish Professors and Lecturers in Great Britain (Polish Research Centre, 32 Chesham Place, London, S.W.1) a letter protesting against the second series of persecutions by the Germans of Polish men of science and others since the War began. The fury of the first German attack on Polish science and culture was raging in November 1939, when 180 professors and assistants of the oldest Polish university, that of Cracow, were deported "as criminals" to the concentration camp at Oranienburg. Now we are witnessing the second German attack on Polish science, carried out in the newly occupied territories and aiming at completing the destruction. On occupying Lwow the Germans executed Prof. C. Bartel, professor of mathematics in the Lwow Technical College (see NATURE of October 4, p. 402); they also arrested sixty other professors, among them a number of elderly men. The German persecutions are an integral part of the methodical campaign aiming at the total destruction of Polish culture. All the Polish universities, technical and agricultural colleges, commercial academies, all research institutes, all scientific societies, including the Polish Academy of Sciences, have been closed by the Germans. The same fate has befallen all secondary schools. The scientific apparatus and the equipment of laboratories have been transported to the Reich. The Polish museums were and still are being looted. Publication of books and periodicals as well as of independent newspapers has been suspended. Monuments which showed the artistic culture of the nation have been pulled down and destroyed.

All the professors of the University of Poznan have been expelled, deprived of all their personal possessions and left starving. Some of them, headed by Prof. Bronislaw Dembinski, honorary professor of history, have died as a result of the dreadful conditions of life to which they were exposed. Eighteen professors of the University of Cracow, among them the most prominent representatives of Polish science, have died as a result of tortures suffered in the concentration camp of Oranienburg. The professors of the Catholic University of Lublin were kept in prison for some months and some of them are still in concentration camps. Recently a number of Warsaw professors perished as victims of undeserved persecution. "To this black record of German persecutions a new page has been added—the persecutions of Lwow. Executions and concentration camps for Polish men of science—that is what the German 'crusade in the defence of civilisation' has brought with it." In view of these new German crimes which bear full witness to a total degeneration of Hitlerite Germany, we feel sure that men of science in all free countries will wish to join in this solemn protest by Polish savants in Great Britain.

Developments in Agricultural Research

THE extended field of activity and additional financial resources which have recently been granted by the Government to the Agricultural Research Council have opened the door to new developments in this branch of applied science. A large part of the Council's activities will still be devoted to co-ordinating, and advising on, the work of the various research institutes to which the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are making maintenance grants, and to furthering the interests of these institutes in every possible way; but it is the Council's intention to devote some part of the funds to be expended at its own discretion, for which it is answerable to the Lord President of the Council, to the furtherance of agricultural research in university departments, and to the enlargement of its own scientific staff. It is, in particular, the Council's desire to encourage both senior and junior research workers in the biological sciences to enter the agricultural field. In pursuance of this policy, the Council has established two new research units under its direct control, a Unit of Animal Physiology, and a Unit of Soil Enzyme Chemistry.

The Unit of Animal Physiology will be under the direction of Sir Joseph Barcroft, with the assistance of Mr. A. T. Phillipson and Dr. R. A. McAnally. This Unit will, by agreement with Prof. E. D. Adrian, be housed in the Department of Physiology at Cambridge, and will work in close liaison with the Institute of Animal Pathology and the Institute of Animal Nutrition. In the first instance, the staff of this Unit will devote a large part of their time to the study of ruminant digestion. The Unit of Soil Enzyme Chemistry will be under the direction of Dr. J. H. Quastel, assisted by Dr. P. J. G. Mann and Mr. D. M. Webley. By agreement with Sir John

Russell, this unit will be housed in the Rothamsted Experimental Station. Dr. Quastel and his staff will, in the first instance, be engaged mainly in the study of the influence on soil fertility of enzyme systems derived from soil bacteria, or from other micro-organisms.

Scientific Films

THE possibilities of scientific films are immense. They appeal directly to the eye, and their appeal can be reinforced by spoken or printed text. Their capabilities in representing motion enable them to illustrate processes which cannot otherwise be adequately conveyed to the mind. By the control of speed they can be used to demonstrate actions taking place too quickly or too slowly for the unaided eye to grasp; and the wide possibilities which they offer in magnification and reduction bring processes of nearly all dimensions within the compass of the screen. The mechanism of motion pictures also enables full use to be made of reversal, superimposition and stroboscopic effects in the production of scientific films. Recognition of the value of these films is leading slowly to their use in general scientific education. Another direction in which their future seems bright, although at present almost unexplored, lies in the popularization of science and in conveying in an acceptable manner some understanding of the relation of science to other forms of human work and culture. A further use of scientific films lies in various fields of research in which permanent records are required of processes in action.

Yet in the sphere of their production, scientific films have many difficulties with which to contend. Their production is scarcely a commercial proposition. They cannot effectively compete with the ordinary popular entertainment films. Also, the technique of their production calls for highly specialized and gifted talent, not likely to be attracted to the business unless the prospects are good. As a consequence, the number of institutions and organizations showing scientific films is small, and it will not expand rapidly until there is a wider selection of better films to draw upon. To promote the use of such films, the Scientific Films Committee of the Association of Scientific Workers, 30 Bedford Row, London, W.C.1, has recently issued a leaflet on "The Scientific Film", in which a summary is given of the possibilities available in the production and use of films for scientific purposes. This Committee offers its services in the selection of films and in drawing up programmes for different types of audience. Having adopted the practice of viewing scientific films as they become available, the Committee is in possession of information of considerable value to prospective users, and incidentally also to film producers. A small grant from public funds for scientific films would be of great educational worth. In its absence, the field is occupied to a considerable extent by films prepared for commercial and industrial firms, many of which are excellent in themselves, but not entirely free from bias of some kind or other. In spite of this, if full use were made of such films as are available, a great step forward would have been made.

Conditions of the Peking Man Bones

IT must always come as somewhat of a relief to the ordinary anthropologist that quite ordinary explanations are adequate to account for conditions to which more romantic solutions have been attached. It is, therefore, with some sense of thankfulness that we learn that Prof. F. Weidenreich has decided ("The Extremity Bones of Sinanthropus Pekinensis." *Paleontologia Sinica*. New Series D. No. 5. Peking: Geol. Survey of China) that the breaking of certain limb bones of Sinanthropus in the caves of Choukoutien has been due to the activities of the hyæna rather than, as he formerly postulated, to a series of cannibal feasts on the part of Peking man. He still believes it necessary, however, to invoke the assumption "that Carnivores and man competed in the breaking of bones both human and animal". May it not be possible that Carnivores have also produced the broken condition of the skulls? In another way this latest publication on Sinanthropus is pleasing, for it makes it quite evident that the Peking man's femur "is identical with the human femur in size, form, proportions, and character of the muscular markings, differing in all these features from the anthropoid thigh bone in much the same way as any human femur". It is also certain that his humerus is exactly as it is in modern man: and the same applies to the only two other limb bones so far discovered—the clavicle and the os lunatum. For some, it may be rather a descent to earth, but for the science of physical anthropology it is surely a gain that we are at length permitted to know that Sinanthropus possessed the most ordinary and typically human limb bones, and that he walked as upright as the best of us.

Scottish Rock Carvings

THE September issue of *Antiquity* contains a note by Prof. V. G. Childe on some finds of rock carvings in Scotland. Two of these are in Argyll and one in Midlothian. The first photograph shows a hind engraved in outline from Gleann Domhain, Argyll. The figure is in profile, two long ears appearing side by side and only two legs. There is a blunt and intriguing tail and an eye is shown. The style of this engraving reminds one forcibly of the Arctic culture rock drawings of Norway and Sweden (Scandinavian Art Group I). Prof. Childe's second photograph is of a fish which has been found near Roslin, Midlothian. This carving is not merely an outline but rather appears to be done in low relief and it, too, might have links with Scandinavia. Not so the third find, of a stylized, rather shapeless, animal figure from Dunadd, Argyll, which is very different in style from either of the other two and might easily belong to a different and later culture group.

The influence of the Scandinavian Arctic Culture—itself probably an offspring of the northern Mesolithic civilization—on eastern Britain has long been suspected, suggested by certain finds of stone implements as well as by the engraving on a piece of flint crust which was found in the earliest levels at Grimes Graves. The new Scottish discoveries, especially the Gleann Domhain hind, powerfully reinforce this

notion, and even go farther with the inference that the Arctic Culture not only reached our eastern coasts, but indeed, penetrated considerably inland—at least in the northern areas of Britain.

Corrosion in Steel Chimneys

In the last twenty years, developments in the size and efficiency of boiler plants have led to the abandonment of huge masonry chimneys serving a number of boilers in favour of a separate chimney for each boiler. In *Engineering* of September 12, Mr. A. V. Staniforth shows that this has been brought about not only for the sake of the advantages accruing during overhaul and repair from such sectionalizing, but also because the very large units, now common, call for much larger chimney areas. The normal chimney was built of lapped riveted plates, but corrosion was found to be very rapid. At one large power station, five steel stacks, each 7 ft. 6 in. in diameter by 80 ft. high, constructed of $\frac{3}{8}$-in. mild steel plates riveted together, had corroded away in parts to paper thickness in five years in spite of annual internal and external cleaning and painting. In all cases the corrosion had become most serious at, and had undoubtedly started from, the joint laps and rivet heads, and was most marked in the upper parts of the chimney. The temperature of the gas entering the chimneys was about 250° F., at which the steel temperature, particularly near the top of the chimney, often fell below dew point, especially during the colder periods of the year. This caused the deposition of moisture, sometimes increased by rainfall. Combining with the sulphurous gases, it formed sulphurous acid which attacked the steel. The moisture running down the chimney collected along the joint laps and rivet heads, and thus was responsible for the especially severe corrosion at these points.

In solving the problem it was considered desirable first to eliminate the points of corrosion, namely, the lapped joints and rivets, and secondly to find some type of lining which would afford adequate protection to the steel plates. Modern developments in electric welding suggested the use of welded butt joint chimneys, which are easy to construct and give a smooth parallel barrel free from all foci for corrosion. In protecting the interior of the chimney plates from corrosion, asbestos sheeting of certain types was found reasonably suitable. The five steel stacks mentioned above were replaced by lined stacks in 1935, and five years later a section of the lining was removed from one of the stacks. It was then found that no corrosion of any kind had taken place and that the mill scale was still on the steel. Another advantage is that the heat-insulating effect of the lining cuts down the heat loss, and so the period during which the temperature of the steel falls below the dew-point is very much reduced. Tests showed that with a gas temperature of 290° F., the outside temperature of an unlined stack was 210° F., while the lined stack had an outside temperature of 150° F. The lower outside temperature of the stack reduces considerably the cost of maintenance of the outside of the chimney by increasing the life of painting.

Health of Hawaii

ACCORDING to the report of the Board of Health of Hawaii for the fiscal year, the lowest death-rate ever recorded for these islands, namely, 7·18 per 1,000 inhabitants, occurred in 1940. There were 3,025 deaths in a population of 423,332, the chief causes being heart disease, cancer, congenital malformation and disease, tuberculosis and nephritis. Pneumonia dropped from the second to the eighth leading cause of death, a fact which was attributed to the use of serum and sulphapyridine, which were distributed free to practitioners for the medically indigent. The birth-rate was 22·62, as compared with 21·79 in 1939. An outbreak of 101 cases of infantile paralysis with 10 deaths occurred during the year. The death-rate from tuberculosis was 63·2 per 100,000, the lowest on record. There were 56 cases of typhoid fever, which were attributed principally to carriers; no cases were traced to milk or to the potable water. There were 77 cases of typhus with 1 death. There were 1 case of human plague which ended fatally and 47 cases in rodents as compared with 129 the previous year.

Announcements

THE Lister Medal for 1942, which is given in recognition of distinguished contributions to surgical science, has been awarded to Prof. Evarts A. Graham, professor of surgery in Washington University, and he will deliver the Lister Memorial Lecture in 1942, or later, under the auspices of the Royal College of Surgeons of England. This is the seventh occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh, and the University of Glasgow.

IT has been decided not to award any Nobel Prizes this year.

THE Tenth International Ornithological Congress, which was to have been held in the United States in 1942, has been indefinitely postponed.

A MALARIA survey of Trinidad was recently begun under the supervision of Dr. Mark F. Boyd and Dr. W. G. Davis of the Rockefeller Foundation.

MESSRS. ROWNTREES, of York, have made a grant to Dr. F. C. Happold, reader in biochemistry in the University of Leeds, of £150 a year for two years for research work on nutritional problems.

ERRATUM.—It was stated in NATURE of October 18, p. 457, that Dr. E. Kodicek, who contributed a paper on post-war relief at the recent British Association meeting, was formerly lecturer in psychology in the University of Prague; this is incorrect. He held the position of head of the Department for Vitamins and Hormones at the University Clinic, Charles University, Prague.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Chromosome Breakage and Sterility in the Mouse

SNELL[2] has shown that the offspring of X-rayed male mice produced before the onset of complete X-ray sterility contain a certain proportion—depending on the dosage—of semi-sterile individuals, which when outcrossed to unrelated animals throw litters of reduced size. This semi-sterility could be shown to be inherited and was assumed to be due to an interchange of segments between non-homologous chromosomes induced by irradiation. The genetical behaviour of semi-sterility was extensively studied in breeding experiments[2,3,1]. A great

a b

PHOTOMICROGRAPHS SHOWING THE ASSOCIATION OF FOUR CHROMOSOMES DURING THE MEIOTIC DIVISION IN MALES OF LINE A (a) AND OF LINE T (b).

number of valuable data on zygotic lethality during the early embryonic development was also collected by various investigators[4,5,6,10], yet so far no cytological analysis of chromosome behaviour in interchange heterozygotes has been attempted. With this programme in view, three semi-sterile lines, A, B and T, each from a differently treated male, were produced by us using the X-ray technique of Snell.

The presence of the interchange was usually determined by the breeding test. Interchange B, however, was first identified cytologically in a number of mice and later verified by the breeding test. The breeding results so far obtained show that the average litter size produced by outcrosses of the semi-sterile individuals in line A is 2·6 (11 litters), in B 4·2 (15 litters), and in T 3·6 (44 litters). In the related but untreated control lines it is 7·7. Spermatogenesis in the interchange hybrid has shown that an association of four chromosomes is regularly present during meiosis (Figs. a and b). In lines B and T it is represented as a chain of four chromosomes, and in A it usually forms a ring. The association of four in an interchange hybrid, if metaphase orientation is at random, will lead to the production of six kinds of sperms in equal numbers; four out of the six will have one chromosome segment in duplicate, another segment not represented at all. Fertilization of eggs with unbalanced sperms will result in the production of 66·7 per cent defective zygotes. These expectations have been confirmed experimentally in plants and Drosophila. We can confirm it for line T of our mice, the only line in which a sufficiently high number of individuals has been tested as yet. Out of twenty-six animals tested eleven proved to be fertile and fifteen semi-sterile, which is a good agreement with expectation, namely, 8·7 fertile and 17·3 semi-sterile.

The cytological analysis of interchange hybrids of lines A, B and T has shown clearly that the different degree of sterility is determined by the frequency of multivalent association and by the type of orientation of the quadrivalent. The behaviour of multivalents during the first meiotic metaphase and the data of the breeding test suggest that in lines B and T a long and short segment of two non-homologous chromosomes are interchanged and that the breakage points are located far away from the centromere. In line A, on the other hand, the interchange involves larger segments with breakage points adjacent to the centromere. The high incidence of sterility in line A is due to the high frequency of non-disjunction which follows.

In line T there was a sudden increase in fertility between the first and following generations. The average litter size in F_2 (6 litters produced by one semi-sterile son of the original X-rayed male outcrossed to various fertile females) was 2·0. In F_3 22 litters produced by outcrossing 3 semi-sterile F_2 males and 4 semi-sterile F_2 females had an average size of 3·7, and in F_4 this average remained materially unaltered at 3·8 (17 litters produced by outcrosses of 4 F_3 males and 2 F_3 females). The 3 F_2 males, however, had not only a very small litter size but also failed to produce litters with several females known to be fertile, although vaginal plugs were observed in two instances showing that mating had taken place but remained unsuccessful. No offspring for breeding could be secured from these males except one daughter which did not carry the interchange. Thus the F_3 consisted only of descendants from the less sterile F_2 individuals. No exceptionally sterile individuals were observed among the F_3, the average litter sizes for each tested individual all ranging near the average for the semi-sterile group of this generation as a whole. These data indicate that, beside the segmental interchange present in all semi-sterile individuals, minor structural changes or mutations with a deleterious influence on fertility were also brought about in the chromosomes by irradiation and handed on by chance segregation to some individuals of the next generation. These additional changes are eliminated rapidly on account of the high degree of sterility they cause when superimposed on the major chromosome rearrangement.

Further experiments are in progress with the view of establishing lines homozygous for the interchanges,

and of combining the different interchanges in order to test whether there is a position effect, and to find out if some of the interchange chromosomes of the various lines are common or not. Meanwhile we may point out that there can no longer be any doubt that X-raying germinal cells in man involves the serious risk of inducing heritable sterility in the descendants owing to embryonic mortality of zygotes with an unbalanced chromosome complement.

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Aug. 3.

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Natural Occurrence of Polythionic Acids

IN 1937 I assisted Dr. A. L. Day in a survey of the thermal region of the North Island of New Zealand, and part of the work carried out for him was the collection of samples of the waters of the most vigorously boiling pools in the various hot spring areas. During the analyses at the Dominion Laboratory, Wellington, advantage was taken of the opportunity to examine the samples for the presence of polythionates. The method used was titration with sodium hydroxide solution after addition of mercuric chloride to the neutralized sample. The examination of seventeen acid waters from seven areas showed the presence of polythionates in only two waters, but these were from the most active springs. One was the "Black Pool" at Ruahine, near Rotorua, the largest and most vigorously boiling pool in the thermal region, and the other, the "Black Geyser", a perpetual spouter at Ketetahi Hot Springs on the slopes of Mt. Tongariro. On the authority of Mitchell and Ward, from whose book the method was taken[1], it was assumed that as the waters contained hydrogen sulphide, the only polythionate present was the trithionate. However, it has since been pointed out to me by Dr. A. Kurtenacker (private communication) that this is not correct.

The occurrence of a polythionic acid in Nature was first reported by J. S. Maclaurin, late director of the Dominion Laboratory, who in 1911 discovered pentathionic acid in the water of the lake in the crater of White Island[2]. This lake, of an area of about fifteen acres, containing 5 per cent free hydrochloric acid, was a feature probably unique in the world. Unfortunately, it no longer exists. It was drained in 1912 to facilitate the working of the sulphur deposits. It is probable that the drainage helped to bring about the landslip and steam outburst that completely changed the character of the crater. Apart from the loss of twelve lives, the cost of the work in this, and later efforts, far exceeded the value of the few thousand tons of sulphur extracted. A little scientific investigation would have indicated the exaggeration in the estimates of the amount and purity of the sulphur deposits. It is doubtful whether the present features offer the same interest to the scientific worker or tourist as those destroyed. The island is still threatened with exploitation, for it has been allowed to pass into private hands, and proposals are occasionally mooted to use the natural steam for the production of salt from sea-water. This is but one example of the regrettable lack of appreciation in New Zealand of the varied, and often unique, features of the thermal region, and there is still no move to safeguard and conserve for posterity all the hot spring areas under one control, for example as a national park.

In 1939 I spent a week on White Island, carrying out chemical and physical investigations on an expedition organized by Dr. P. Marshall. Fumaroles and steam vents are now the main type of activity, and hot springs are rare. However, at the bottom of a depression about 50 ft. deep, named "Middle Crater", there was found a vigorously boiling pool, and a sample of this was taken.

Since the previous work, methods for the complete analysis of solutions containing polythionates had become available in the book by Kurtenacker[3]. These depend on titration, with iodine solution, of the varying amount of thiosulphate formed by the reaction of the polythionates with sulphide, sulphite and cyanide. Only one litre of the water was available for analysis, and from this it was necessary to remove a large amount of ferrous iron. The analysis indicated that the water contained 170 mgm. per litre of tetrathionate ion (S_4O_6''). This amount is not much less than that found by J. S. Maclaurin[2] in the water of the lake, 240 mgm. per litre, although the polythionate found by him was the pentathionate.

A sample sufficiently large to permit a thorough investigation of the polythionates present was obtainable only from a more accessible area, and early this year it was possible to obtain a four-litre sample of the "Black Geyser" at Ketetahi Hot Springs. This sulphate water of pH 5·4 was found to contain 99 mgm. per litre of tetrathionate ion (S_4O_6'') and 66 mgm. per litre of pentathionate ion (S_5O_6''). Further work appears desirable on the particular polythionates which can occur in Nature.

The presence of polythionates in hot springs is not merely of academic interest. The origin of these sulphur acids might be ascribed either to the oxidation of hydrogen sulphide by the oxygen of the air as a step in the formation of sulphuric acid, or to the interaction of hydrogen sulphide and sulphur dioxide, present as constituents of the ascending volcanic steam. The first explanation does not seem probable. Some confirmation of the second explanation is given by the fact that small amounts of sulphur dioxide were actually found in the fumarole gases of White Island. Besides the discovery of J. S. Maclaurin, the only instance of the natural occurrence of polythionates is that recorded by Day and Allen[4], who found pentathionate in incrustations in the crater of Lassen Peak. In this case also, sulphur dioxide was found in fumarole gases.

I have pointed out[5] that if the passage upward of magmatic steam is slow enough to enable equilibrium in gas reactions to be maintained until the steam has cooled to 400°–500° C., there would be no appreciable amount of sulphur dioxide unconverted to hydrogen sulphide. The presence of sulphur dioxide in fumarole gases, and possibly also the presence of polythionates in the hot springs, would indicate rapid

cooling from a magma near the surface. It would be much simpler to estimate polythionates in waters than to determine sulphur dioxide in fumarole gases, and this estimation might be a useful way of judging the activity of an area, or following changes in activity with time.

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Flow of Air through Rocks at Low Rates

DURING routine measurements of the permeability of rocks carried out in 1939–40, certain anomalies were observed when the rate of flow was extremely low. It was seen that when the rock was highly impervious and the velocity of the flowing air was consequently low due to limitations in the pressure, a plot of the pressure loss *v.* rate of flow did not yield a straight line passing through the origin. Darcy's law having been established with such rigour by many workers before, however, necessitated the rejection of the anomalous results as due to "experimental errors". The same type of anomalies, however, were again observed recently in measuring the permeability of other samples. Thus, it was decided that the phenomenon be investigated, after having first refined and adapted the apparatus for measurements at extremely low rates of flow.

Fig. 1 shows the results on one sample which was subjected to the test. The ordinate is the product of $\bar{Q}$, the rate of flow at mean pressure, $(P_1 + P_2)/2$, where P_1 and P_2 are inlet and outlet pressures in atmospheres, and μ the viscosity of the air at the temperature of observation, divided by the cross-sectional area of the sample, A. The abscissa is the differential pressure across the sample $(P_1 - P_2)$ divided by the length of the sample, L. It is seen that at low rates of flow, or low differential pressures, the graph is a curve and not a straight line.

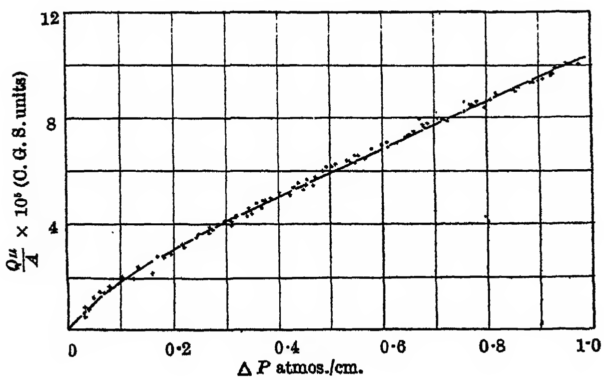

Fig. 1.

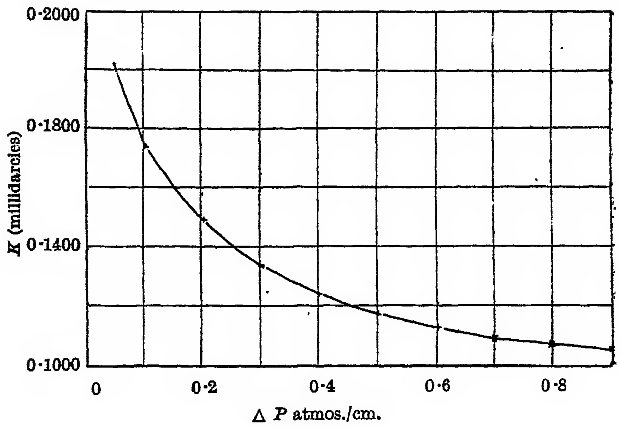

Fig. 2.

Fig. 2 shows the results in another form. The permeability, which is the tangent at each point of graph on Fig. 1, is plotted against the pressure differential. It is seen that instead of the constant value for permeability demanded by Darcy's law, a variable permeability is obtained, falling to an assymptotic value at higher rates of flow. The assymptotic value is what is usually obtained in permeability measurements using fairly high rates but necessarily limited to the viscous regime.

The possibility of turbulence is completely excluded by the nature of the tests, by the fact that at higher rates of flow in Fig. 1 the curve straightens out into the normal viscous regime curve, except for the anomaly that it does not pass through the origin exactly, and further by the fact that the region where the graph curves does not follow the equation

$$\Delta p = av + bv^2.$$

Other tests reveal the fact that the permeability value first increases to a maximum, after which it descends in value until it reaches the assymptotic value indicated.

Full description of the experiments will be published later in another place.

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The Philosophy of Physical Science

SIR ARTHUR EDDINGTON has not met my point (NATURE, Sept. 20, p. 341). Assuming, in accordance with his claim, that criteria could exist which would determine that a law was applicable to certain experiences, I asked what he would do if such experiences were found to violate an "inviolable" law. He has related what Adams and Leverrier did when experience afforded an opportunity of testing a law not held to be inviolable. My question still remains.

I agree that if a law appears to be broken, the physicist asks whether a factor has been overlooked. He also reviews his calculations to look for errors, repeats his observations to make sure he was not

mistaken, and even suspends judgment for a while, in daily expectation, like Mr. Micawber, that something will turn up. I assumed in my former letter that all that had been done. The alternatives I mentioned are then the only ones left open. If a historical reference is necessary (which I do not admit) let it be to Mercury rather than Uranus. Here an unknown planet was looked for and not found. What happened was that the law was abandoned. (I have discussed the problems of both Uranus and Mercury elsewhere[1], taking into account also the difficulty mentioned by Eddington arising from "the congruence of gravitational and radiative sources". The facts are perfectly consistent with the view of scientific law as an expression of relations found in experience, though not with the view that science is a description of an external world of physical objects.)

Some interesting points are raised by Eddington's further elucidation of his position, but I refrain from following them up since it is already difficult enough to concentrate the discussion on the main issue. It is no digression, however, to suggest that when he says he is trying to make sense of modern physics but not of experience, he contradicts himself, for modern physics expresses relations found in experience. I find it difficult to believe him serious when he writes: "I cannot find that modern physics imposes any such condition of relevance [that is, a 'condition implying some special relevance to experience'] on the laws which it accepts as fundamental." Suppose the facts now available concerning the orbit of Mercury, gravitational deflexion of light, etc., had accorded with Newton's law and not with Einstein's. I am ready to believe that Eddington's trust in human reason would lead him to accept Einstein and reject Newton, in the sure and certain hope that some perhaps never to be discovered sources of gravitation existed which would justify him. But does he seriously assert that "modern physics" would do the same? If so, twenty thousand physicists will know the reason why.

In reply to the question implied in Sir Arthur's last paragraph, I would say that at the top of things is experience. I was, of course, adopting his metaphor, which is ill-adapted to my view. I do not picture science as digging beneath a surface layer of experience to reach some metaphysical necessity, but if I do express myself in that way I must say that unless the bottom layer can itself support experience (other experiences, of course, than those through which the spade went), then science is digging in the wrong field. But the picture is very unsatisfactory. I prefer to think of the experiences so far obtained as arranged by us in a pattern. By inspection we can infer the plan of the pattern and continue it beyond the area covered by existing experiences; and if future experience falls into place in the extended pattern, we have some confidence that the plan is the one we are seeking. If it does not, then we rearrange existing experience into another pattern into which the new experience will fit. The essential point is that experience is the beginning and end of the business: it suggests the pattern and controls its development.

I await an answer to the question: If the scheme of inviolable law is violated by an experience to which the criterion shows it to be applicable, what about it?

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[1] "Through Science to Philosophy", pp. 93–95 (Oxf. Univ. Press, 1937).

I FIND it very helpful in all discussions on the philosophy of science to make two distinctions. The first is to restrict the word 'science' to those studies involving experiment with something other than symbols. This rules out mathematics as a science and prevents, for example, the confusion that arises when it is held up as an example of the perfect science. The second distinction, which is of the greatest importance, is to distinguish between science and exact science. Exact science is that part of science which deals with the numbers produced by the reading of pointers—Eddington's "pointer readings". This is very far from being the whole of science, although it is often held up as being the ideal aim of all sciences. (It is sufficient to recall that the theory of evolution, perhaps the most convincing of all scientific theories, does not rest on measurement or even on simple counting.) Science deals with the experiences of ordinary life, tables, octopi, schizophrenic persons and so on, but exact science deals only with numbers obtained by conventional methods of measurement. Thus it may well happen that the philosophy of science is different from the philosophy of exact science.

To account for the structure or relationships of symbols we naturally start with symbols and use methods of dealing with symbols, namely, mathematical methods. But to account for the structure of tables, we clearly cannot start with symbols, but must follow Newton's rules of reasoning in philosophy, namely, "We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising; nor are we to recede from the analogy of Nature. . . . The extension, hardness, impenetrability, mobility, and vis inertiæ of the whole result from the hardness, impenetrability, mobility, and vis inertiæ of the parts; and thence we conclude the least particles of all bodies to be also extended, and hard, and impenetrable, and movable, and endowed with their proper vires inertiæ. And this is the foundation of all philosophy."

Newton's philosophy is the philosophy of science; Eddington's is the philosophy of exact science. Newton attempts to account for the experienced properties of bodies; Eddington attempts to account for the relationship between the numbers produced by acts of measurement on the bodies, and admits that he is not trying "to make sense of experience". Thus Eddington has only to account for symbolic relations and so he starts with symbols—relata and relations—"the relata are the meeting points of the relations"[1]. Their structure "has some significance in regard to the ultimate structure of the world—it does not matter much what significance"[2]. His suggested method is to start with a symbolic structure of great generality and build up other symbols having various relationships. He then expects the scheme of relationships arrived at by the analysis of ***metrical*** observational knowledge to be identifiable among the plethora of schemes arrived at *a priori*. Once this is done, the rest of the metrical properties of the universe could be predicted.

Some further light may be thrown on the numbers resulting from acts of measurement by some considerations which I have put forward recently[3]. Stated briefly, these considerations start with the fact that numbers are put into Nature by the physicist, and it is suggested that, by studying the conventional measuring operations by which numbers

are put in, we may be able to predict something about the numbers which come out. It appears that only two direct methods of introducing numbers are available, the measurement of length and the measurement of time. If we take L and T to represent a length and a time measurement respectively, it follows that the measurement of all physical quantities can be represented by L and T raised to various powers, the powers representing the subsequent treatment of the numbers, that is, whether they are multiplied or divided, etc. But L and T are not independent, for a measurement of length involves an interval of time, so that it is a space-time interval that is measured and a "pure" length measurement is not possible. This is a result of the finite velocity of light which is taken as a brute fact of Nature. This space-time interval can be symbolized by a number in two ways, either by measuring its length or by measuring the corresponding time interval and multiplying by c the velocity of light. Consequently we have a relation connecting length and time measurements, namely, $L=cT$: thus we could say that c is the rate of exchange between a length measurement and its corresponding time interval.

Now if we have a case where numbers have been introduced in two different ways—and this has arisen in electromagnetism where we have the electromagnetic and electrostatic systems—then if we take the ratio of measurements of the same physical quantity on the two systems, we can only get the rate of exchange between the two systems of introducing numbers or some power of it. But the measurements on the two systems can only be L and T raised to different powers, and if these are equivalent, they must be interchangeable by means of the equivalent relation $L=cT$. Thus c, or some power of it, must be the ratio of numbers expressing the value of a quantity on the E.M. or E.S. systems.

Sir Arthur has suggested a case where this might not be so, but from the above point of view, the ratio cannot be anything else but a power of the velocity of light. This conclusion involved the experimental result that the velocity of light can be *measured* to be a finite number: this could not have been inferred *a priori*, although, as Sir Arthur says, it could not have been measured to be infinite. There is a tertium quid: it might not have been measurable at all.

An analogy with two other systems of introducing numbers as symbols for aspects of experience, namely, the dollar and pound monetary systems, may help to make this clearer. The measuring of the magnitude of a physical quantity on the E.M. and E.S. systems, and showing surprise that the ratio of the numbers turns out to be a power of the velocity of light, and then concluding that light is electromagnetic in nature, is, on this view, as absurd as measuring the value of a piano in dollars and pounds, showing surprise that the ratio of the numbers is the same as the dollar exchange given in the financial columns of the newspaper, and then declaring that a piano is financial in its nature.

Sir Arthur says that the important question is whether the physicist will recognize "the bottom of things" when he reaches it; but cannot we say that we have *a priori* knowledge that at the bottom of symbolic relationships will be the relation of symbols ? And cannot we say with Newton, that we know *a priori* that at the bottom of things, in the case of tables, octopi and schizophrenic persons, lies something which is not a symbol—not a "vain fiction of our own devising" ?

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[1] "The Nature of the Physical World", p. 230 (Camb. Univ. Press).
[2] "The Mathematical Theory of Relativity", p. 213 (Camb. Univ. Press).
[3] *Proc. Phys. Soc.*, 53, 418 (1941).

I AM glad to have had the opportunity in three earlier letters of debating the difficulty which some physicists find in my scientific epistemology; but I think the time has now come to conclude my share in a discussion which might continue interminably. It only remains to comment briefly on the letters printed above.

Prof. Dingle begins and ends his letter with a question which cannot arise. If the fundamental ("inviolable") laws are not assertions about experience, they cannot in any circumstances be violated by experience. In regard to the rest of his letter, the imagined misbehaviour of Mercury does not differ materially from the imagined misbehaviour of the Michelson-Morley experiment which has already been discussed. In his third paragraph Dingle contradicts me, but I see no justification for his assertion that *I* contradict myself.

Dr. G. B. Brown's letter, with which I am in general agreement, provides a text for some concluding remarks. He emphasizes that the characteristic features of "the philosophy of exact science" come from the fact that exact science is concerned with *numbers* resulting from acts of measurement. Thus we shall get to the root of the matter more directly if we focus attention on numbers—if on the experimental side we consider physical quantities rather than physical objects, and on the theoretical side we consider the numbers which appear in the fundamental laws (namely the fundamental constants) rather than the laws themselves.

Our laboratories and observatories are occupied in amassing numbers most of which could certainly not be foreseen without measurement. But theoretical physicists have sublimated out of this numerical material a set of fundamental laws which (after removing the inconsistencies between current wave mechanics and relativity theory) are found to contain no unforeseen numbers. The co-efficients in the fundamental equations are all of the same type as the co-efficient $\frac{3}{2}$ in the specific heat of a monatomic gas, or as the ubiquitous 2π, the mode of entry of which into the formulæ can be traced without ambiguity. This gulf between the system of the theoretical physicists, which involves no numbers except such as are clearly of their own devising, and the everyday occupation of physicists and astronomers with numbers which are clearly not of their own devising, gives a jolt to one's philosophy. When it became quite clear that the gulf was complete, leaving experience on one side and the theoretical system on the other side, without a single bridge so far as *numbers* are concerned, a radical change of outlook became necessary It is not likely that a first constructive effort to find a scientific philosophy adapted to this new situation has achieved finality; but, whatever defects may be found in it, there can, I think, be no going back to the type of outlook which Sir James Jeans and Prof. Dingle support.

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NATURE AND MEASUREMENT OF WHITENESS

THE mechanism by which a 'white' substance reflects light is fairly simple and is fundamentally the same for crystalline and vitreous powders such as snow and borax, for suspensions such as milk, paint and opal glass, and for fabrics and paper. In all these cases, a multiplicity of transparent particles or fibres is suspended in a transparent medium of different refractive index, and a beam of light incident on the substance is specularly reflected and refracted at a large number of random interfaces, without any transformation and with very little absorption, resulting in a diffused reflexion. A coloured substance has the same mechanism, except for interference colours, but the minute particles also exert selective absorption on the light passing through them. If the difference of the refractive indexes between the particles and the surrounding medium is reduced, a white substance will have a reduced reflexion factor owing to reduction of the interfacial reflexion, and for the same reason a coloured substance will have an increased coloration, as may be simply shown by wetting a white or a coloured fabric. No reflecting substance has colour of its own, but only introduces colour by virtue of the selective absorption which it exerts on light falling upon it, and a white substance is uniquely characterized by its absence of selective absorption of light.

A 'white' light has no such unique character, and the range of lights which are called white can only be defined subjectively from the white-hot metal in a furnace at a temperature of about 1,700° K. to north sky daylight the colour temperature of which may be 10,000° K. It is, however, essential that standard white illuminants should be employed for measurement of white and of coloured substances, and ten years experience of Illuminants *A*, *B* and *C* specified by the Commission Internationale d'Éclairage in 1931 has proved them adequate for most purposes.

The Colour Group of the Physical Society held a discussion on whiteness on September 24, and three papers were read on different aspects of the problem of measuring near-whites. The introductory paper by J. G. Holmes, of Messrs. Chance Brothers and Co., Ltd., gave the theoretical background and indicated some of the visual and colorimetric problems peculiar to near-whites. It was pointed out that a white substance can be picked out quite critically either in daylight or in artificial light, whereas a particular yellow or blue calls for an effort of memory and for uniformity of lighting, and this sensitivity to small departures from whiteness is stimulated by the frequency with which white and near-white substances are employed in everyday life. The exact measurement of their colour is more exacting than that of coloured substances, and instrumental methods may be hard taxed to detect and to measure differences which are quite obvious to the unaided eye. The amount of departure from whiteness is usually expressed as the difference between the colour of the light reflected from a substance and the colour of the light incident upon it; a truly white substance making no change in the colour of the light.

A brief review was given of the instruments available and of their usefulness in industry. The usual type of trichromatic colorimeter is not satisfactory, as the method of building up a white light by adding together three strongly coloured primary lights produces a very uneven spectral energy distribution and, when this is compared with the light reflected from the specimen, the difference in energy distribution in the two halves of the colorimeter field renders the match liable to appreciable variation from one observer to another. This disadvantage may be reduced by employing a subtractive colorimeter, in which the selective absorption of the specimen is approximately reproduced by that of the subtractive filters, but all visual colorimeters have a small field size, leading to poor sensitivity. Spectrophotometric measurements are free from these disadvantages and good results can be obtained by visual or photoelectric 'abridged spectrophotometers', which measure reflexion factor in eight or more comparatively narrow spectral bands selected by filters, and by complete spectrophotometers which measure re-reflexion factor in monochromatic light at a series of wave-lengths.

Dr. V. G. W. Harrison, of the Printing and Allied Trades Research Association, dealt with colour tolerances and methods of control in the paper industry. The natural colour of paper is yellowish, its hue being about 5800 A. and its saturation about 12 per cent with C.I.E. Illuminant *B*; the paper trade tends to call this 'white', and to call a true neutral pulp 'blue-white'. There is a marked preference for the latter colour which is not due to any tradition in the trade, and Dr. Harrison described experiments in which twenty observers were asked to compare the brightness of eight different papers. Analysis of their results showed that the physical reflexion factor of a paper is no measure of its brightness by subjective estimation, and that a blue-white paper actually appears brighter than a natural white paper the reflexion factor of which is about 6 per cent higher than the blue-white.

It seems that the eye is more sensitive to changes in saturation, or depth of colour, than in reflexion factor, and a paper is judged brighter if it has less selective absorption, which explains the common practice of a beaterman in a paper mill, who adds a dash of blue or black to his pulp to 'brighten' the paper. The accepted commercial tolerances are very close when papers have to be bound together in a book, and Dr. Harrison referred to a single run of paper from one mill which had to be graded visually into six 'colours' in order to ensure consistency. Colorimeter measurements failed to show any significant difference between the six grades, and in order to get sufficiently accurate data it was necessary to send the specimens to the United States for measurement on a recording photo-electric spectrophotometer. Subsequent tests on a photo-electric 'abridged spectrophotometer' gave very similar results, although these were not suitable for direct calculation of the trichromatic coefficients, and the tolerance for good commercial quality appeared to be closer than $\pm 0{\cdot}0005$ in the C.I.E. trichromatic coefficients and $\pm$ 0·5 per cent in the reflexion factor.

A manufacturer has to work to a standard pattern, and it is very difficult to check gradual change due to dirt and ageing without accurate measurement. An appeal was made for the provision of a rapid and accurate spectrophotometer available for frequent and inexpensive industrial testing of patterns,

preferably under the auspices of a testing centre or research association.

C. G. Heys-Hallett, of the Morgan Crucible Co., Ltd., discussed the apparent whiteness of cinema screens. Coloration of the screen itself and the colour of the light from the arc are found to vary widely in many cinemas and to lead to serious distortion in the excellent colour films of the present day. This distortion can be overcome by standardization, but it is first necessary to measure the apparent colour and brightness of the combination of arc, optical projection system and screen in order to demonstrate to cinema proprietors the necessity for uniformity. Such measurements need not be on a standard system and do not need the high accuracy required in the paper industry, and Mr. Heys-Hallett described a photo-electric brightness meter which indicates screen brightness with no film in the projector and the relative brightness with each of three colour filters interposed in the beam.

The variation from cinema to cinema is large, being more than 50 : 1 in screen brightness and about 30 per cent in colorimetric saturation, with the result that many films are shown at a disadvantage. The variation in brightness is attributable to the use of the most powerful arc lamps in some of the smaller modern cinemas and unsuitable projectors in some of the older cinemas, rather than to the reflecting properties of the screen; whereas the variation in colour is due to the use of low-intensity and high-intensity arcs, the variety of mirror and lens collecting systems and the rapid ageing of the screen. It is interesting that the use of a blue filter in the projector to correct a yellowish colour is a definite disadvantage, contrary to experience in the paper industry, as the loss of screen brightness causes more subjective colour distortion than the partial correction given by the blue filter.

Demonstrations were given by lantern slide, and it was suggested that if the projected colour and brightness could be standardized at any practical value, colour films could be made to suit. Such a standardization could fairly easily be applied also in the United States and on the Continent, but it would restrict the development of huge super-cinemas until more powerful light sources are available.

THE 'G.E.C. HEAVY ALLOY'

IN an article on the new 'G.E.C. Heavy Alloy' published in the *G.E.C. Journal* of August, G. H. S. Price and S. V. Williams, of the G.E.C. Research Laboratories, in conjunction with C. J. O. Garrard of the Witton Engineering Works, describe the preparation, properties and industrial uses of a tungsten alloy which is fifty per cent heavier than lead and has the tensile strength of a good-quality steel.

Of the common metals, lead is the only one which is substantially heavier than the general engineering materials. Lead, with its excellent corrosion-resisting properties, is a very useful metal, but it is weak mechanically, and for this reason its use is limited to those applications where the stresses are low. The precious metals such as gold or platinum are heavy metals, being two to three times as heavy as iron or copper, but their high price prohibits their use for general engineering purposes. Tungsten, however, has a density equal to that of gold and is also relatively cheap. A considerable tonnage of tungsten is used annually as an alloying element in the production of special steels, and for this purpose the metal is added in the form of powder or as a ferro-tungsten alloy. Tungsten is characterized by a very high melting point (3,400° C.) and this precludes the production of the pure metal by ordinary metallurgical processes. Pure tungsten in the form of ductile wire or sheet such as is used in the manufacture of electric lamps or radio valves, is produced by a powder metallurgical process. The successful development of the process about thirty years ago was one of the first and most important examples of this method of producing metals and alloys, a method which has been extended in many directions, particularly during the last few years.

So far as tungsten is concerned, a bar of pressed powder is sintered to a high temperature and afterwards worked by swaging, drawing or rolling to produce the metal in wire or sheet form. The sintering temperature required is in the region of 3,000° C. and this is obtained by passing an electric current (about 2,000 A. per 1/16 sq. in.) through the bar. The method of sintering, however, limits the size of the bar that can be conveniently handled, and having regard to the fact that it is only after a considerable amount of work has been done on the sintered bar that the metal approaches its theoretical density, it is evident that fully dense tungsten cannot be produced in massive form.

In the first instance, attempts were made to produce an alloy of tungsten and lead. Tungsten powder was mixed and pressed with a sufficient quantity of lead powder to fill the interstices between the tungsten particles, when the mixture was heated. It was found, however, that tungsten and lead do not wet each other, and homogeneous masses could not be produced. It was known that nickel and tungsten alloy very readily, and experiments were made using mixtures of tungsten powder with 5–10 per cent nickel. On pressing and sintering to a moderate temperature, alloys were obtained with densities of the order of 16·5–17 gm./c.c., which is more than twice that of steel (7·8) and about 50 per cent greater than lead. It was then found that the addition of a certain amount of copper assisted production, and although the quantities of nickel and of copper can be varied, the material which is known as 'Heavy Alloy' usually contains 90 per cent tungsten, 7·5 per cent nickel and 2·5 per cent copper. In addition to its high density, 'Heavy Alloy' has a tensile strength comparable with that of a good quality steel.

It is an interesting fact that although the light alloys of aluminium and magnesium are playing such a leading part in modern aircraft construction, it is in this field that ever-increasing use is being made of 'Heavy Alloy'. It is well known that tungsten is practically unmachinable, but 'Heavy Alloy', although it contains about 90 per cent tungsten, has excellent machining properties. The development of 'Heavy Alloy' with a tensile strength of 40 tons/sq. in. and a density more than twice that of steel opens up new possibilities for the designer.

CINEMA ACOUSTICS AND TELEVISION RECEIVERS

As was mentioned in the issue of NATURE of February 15, the Institution of Electrical Engineers now publishes extended abstracts only of papers in Part I of its *Journal*, the full papers being issued later in either Part II or Part III, according as the subject-matter of the paper is appropriately classified as power or communication engineering. Part III includes the Proceedings of the Wireless Section of the Institution, and the September issue of this part contains three related papers in full.

The first of these is by Messrs. C. A. Mason and J. Moir, and is entitled "Acoustics of Cinema Auditoria", and the paper describes the results of investigations made to discover the reasons for the difference in performance of sound reproduced by identical equipment in apparently similar cinemas. It was apparent from the preliminary investigations in four different theatres that overall frequency characteristics and reverberation times were not the controlling factors for good sound quality, which is defined in terms of both intelligibility and intimacy, the latter term being used for the impression conveyed to the audience that the sound actually proceeds from the picture on the screen. Experiments were then conducted with an impulse source comprising a short train of waves of a fixed audio-frequency emitted through the loud-speakers. By means of a microphone and cathode-ray tube equipment, measurements were then made of the paths taken by the reflected sound in the auditorium.

The results showed first that there was little distortion in the amplifiers and loud-speakers, but that the sound received in the auditorium comprised a direct pulse and some reflected pulses, the number and magnitudes of which depended upon the design and shape of the auditorium. The authors conclude from their investigation that while the reverberation-time of a cinema should approach the optimum value for good intelligibility, it is also necessary that the shape of the auditorium should be such as to avoid reflected-sound paths differing greatly in length from the direct path. The paper concludes with a detailed discussion of the practical design of an auditorium with good intimacy, as well as intelligibility, properties.

The second paper is by B. J. Edwards, and is entitled "The Design of Television Receiving Apparatus". This paper comprises a detailed description of the design of a particular form of receiving equipment for television reception to the standards provided for by the B.B.C. transmitter at Alexandra Palace prior to the outbreak of war in 1939. In portraying the detailed electrical and mechanical features of the design, the author shows the fundamental reasons for the adoption and evolution of the particular methods employed. For example, the advantages and disadvantages of electric and magnetic deflexion in cathode ray tubes are demonstrated, and in justification of the adoption of the fully magnetic tube, it is claimed that it gives reproduction of a television picture of superior definition and brightness, and that it lends itself to a slightly more economical design of circuit.

In the concluding portion of the paper, some speculation is given to the trend of design for television reception. The possibility of a general increase in the carrier frequency up to the order of 100 Mc./sec. is envisaged, and this will bring with it certain problems in the attainment of selectivity for reception; also the general demand for a larger picture is likely to result in the development of the small projection type of cathode-ray tube, giving a picture of high intensity of illumination, in association with a suitable projection lens constructed possibly of a suitable plastic material at a favourable price.

The third paper under consideration is of a theoretical nature. It is on "Electromagnetic Waves in Metal Tubes of Rectangular Cross-Section" and is contributed by J. Kemp. The attenuation of electric waves propagated through the interior of metal tubes of rectangular cross-section is calculated by the familiar telephone transmission formulæ, instead of by the usual classical method first used for this problem by Lord Rayleigh. The present author states that the characteristic advantages of the former method are its simplicity and the directness with which the final results emerge. The method reveals the existence of a link between two seemingly disjointed branches of telecommunication, first the classical circuit comprising a 'go' and 'return' path, and second, the transmission of waves through a hollow metal tube without a return path in the conventional sense.

DRUGS FROM THE EMPIRE

The Imperial Institute has reprinted as a booklet an article from the *Bulletin* of the Institute by Dr. M. Ashby*, surveying the possibilities of producing in the Empire drugs hitherto obtained from Central Europe. Dr. Ashby has done his work well and the publication is timely. There has been much unco-ordinated and misdirected activity in the field of drug supplies and this paper helps to set the problem in perspective. Two basic considerations have tended to be forgotten by enthusiasts who have sought to encourage new cultivation. One is that energies should be directed to essential drugs only; the other that to the commercial grower, the problem is a business problem as well as a patriotic one. By reason of lack of early official guidance, many enthusiastic amateurs in Great Britain are wasting both energy and ground in the collection and cultivation of plants having the weakest of claims to being essential in therapeutics. Dandelion, coltsfoot, camomile and the leaves of the lime are a few examples. They command good prices, but those who grow or harvest them would do better to concentrate on potatoes or onions. Belladonna, hyoscyamus, stramonium, digitalis and perhaps colchicum

* War-Time Drug Supplies and Empire Production. By Dr. M. Ashby. Pp. 39. (Imperial Institute, London, S.W.7.) 1s. net.

are probably the only drugs upon which ground or energy should be expended in Great Britain, and the cultivation of the first three is a task for the expert grower. One lesson of the War of 1914–18 which has been forgotten is that the cultivation or collection and the drying of medicinal herbs cannot be undertaken by amateurs efficiently. Inevitably there is great wastage and disappointment. Dr. Ashby emphasizes this in his sections on cultivation, harvesting, preparation and drying.

The problem for the commercial grower is, at bottom, whether he can get a price for his harvest sufficient to pay him to put extra land under cultivation. So far the Ministry of Health has fought shy of guaranteeing prices and the growers have consequently hung back. The yield per acre of ground under medicinal herbs compares at best unfavourably with the yield under foodstuffs, and the grower has in mind always the possibility of an ending of hostilities before his crop is disposed of. This is to-day the obstacle for the home grower: how much more is it likely to prove an obstacle for the Dominion or American grower. Dr. Ashby wisely emphasizes the need for some form of Government protection if Empire cultivation is to flourish.

The Ministry of Health has an advisory committee upon the cultivation of medicinal drugs, but there is still much confusion and unco-ordinated effort. What is needed is (1) active discouragement of the amateur or professional growing or collecting of herbs which have no important therapeutic value; (2) the allocation among home and overseas growers of future requirements of valuable herbs, with guaranteed prices; (3) the co-ordination of research into the conditions of cultivation that will produce the optimum yield of the needed constituents of the herbs.

There is little indication that the present committee has seriously settled down to this triple task, which is indeed less one for the Ministry, however able its advisory committee, than for a body such as the Agricultural Research Council in daily contact with the practical details of modifying plant stocks in required directions and with the relative value to the country of putting land under medicinal herbs or food.

THE MACKAY RADIO AND TELEGRAPH COMPANY COMMUNICATION SYSTEM

COMMANDER M. H. ANDERSON has contributed a paper to *Electrical Communication* (No. 4, 19, 1941) giving a historical account of the growth of the Mackay Radio and Telegraph Co., the successor of the radio communication business of the Federal Telegraph Company.

The Federal Telegraph Company commenced activities in California in 1909; it was organized by a group of Stanford University men who had secured the American rights to the patents of Poulsen and Pedersen of Copenhagen, Denmark. Up to that time the only practical method of radio communication had been by the use of damped waves generated by spark-type equipment. Operation was confined largely to radio communication with ships at sea; the use of radio for point to point communications was very limited, largely because of the inability to cover in a trustworthy way long distances, particularly in the day-time. The arc type of high-frequency generator developed by the Danish inventors made possible the use of sustained or undamped waves. This gave the Federal Company a definite advantage, and it established radio telegraph services interconnecting San Francisco, Los Angeles, San Diego and Portland (Oregon) in 1911, and San Francisco and Honolulu in 1912, and competed for business with the existing cable and land line companies.

The immediate success of the long-distance circuit between San Francisco and Honolulu encouraged the United States Navy Department and the Federal Telegraph Company to install in 1912 a Federal arc transmitter at the naval radio station at Arlington, Virginia, as a result of which this station was able to communicate with the San Francisco and Honolulu stations, during daylight hours, a feat never before accomplished. Eventually the Navy Department adopted the Federal arc system as standard for its services. In 1913, an extensive construction programme was started, including a chain of high-power naval radio stations for connecting Washington, D.C., with the Canal Zone, California, Hawaii and the Philippines. These ranged in power from 100 to 350 kw. and were supplemented by a system of medium-power equipments located at all important naval establishments on United States territory and on ships of the American Fleet. The climax of this development was reached when the Navy Department built the large radio station near Bordeaux, France, during the War of 1914–18, for which the Federal Telegraph Co. supplied two transmitters of 1,000 kw. each.

In 1914, the Federal Telegraph Co. entered the marine radio field at San Francisco, enabling ships plying the Pacific to secure daylight communication over great distances. Activity in this field developed rapidly.

When the United States declared war in 1917, Federal Telegraph's radio stations were taken over by the U.S. Navy, but the company continued its domestic telegraph business by utilizing leased wire circuits. In 1921, it constructed a new communication system along the Pacific coast with three complete duplex channels between San Francisco and Portland and three between San Francisco and Los Angeles. Other cities were connected by local lines to this main radio trunk system, so that by 1923 the Federal network included offices in Seattle, Tacoma, Portland, San Francisco, Oakland, Los Angeles and San Diego, besides marine radio stations.

In 1928 the Federal Telegraph Company's system was acquired, along with other properties, by the International Telephone and Telegraph Corporation, the name having been changed to the Mackay Radio and Telegraph Company (California) during the year 1927. The change in ownership occurred at the time when high-frequency vacuum tube transmitters were coming into use, resulting in reduction in the cost

of establishing radio circuits. The Atlantic and Pacific groups of offices are interconnected by radio trunk circuits between New York and San Francisco, New York and Los Angeles and Chicago and San Francisco. This closely knit domestic system serves main business and population centres and the contiguous districts, totalling more than eight hundred communities. Messages may be filed with Mackay Radio to thirty-one countries and by means of its associated companies it can accept messages to any country in the world.

The third division of Mackay Radio Service—communication with ships at sea—is carried out by six powerful coastal stations. A Marine Division is maintained through which ship owners and operators may secure modern ship radio equipment, properly installed and adjusted to obtain the maximum range of communication.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

TUESDAY, OCTOBER 28

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. E. H. Hunt: "High Places of Sacrifice in Palestine and Petra".

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. J. C. Dawes: "The Cleansing of Towns and Cities".*

THURSDAY, OCTOBER 30

CHEMICAL SOCIETY (Joint Meeting with the Plastics Group of the Society of Chemical Industry) (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. C. Redfarn: "The Constitution of Plastics".

FRIDAY, OCTOBER 31

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Sir Westcott S. Abell: "Merchant Sea-Power, 1919–1939" (Tenth Andrew Laing Lecture).

SATURDAY, NOVEMBER 1

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. E. B. Bailey, F.R.S.: "How Scottish Recumbent Folds were Discovered".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE (MAN) TO TEACH CHEMISTRY AND MATHEMATICS—The Principal, Dudley and Staffordshire Technical College, The Broadway, Dudley, Staffs. (October 30).

INSPECTOR OF SCHOOLS (WOMAN)—The Director of Education, Education Offices, Deansgate, Manchester 3 (October 31).

ASSISTANT SPEECH THERAPIST—The Director of Education, Education Department, Newarke Street, Leicester (November 1).

INSTRUCTOR IN WORKSHOP PRACTICE AND PROCESSES in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (November 3).

LECTURER IN CHARGE OF THE MARINE ENGINEERING SCHOOL of the Hull Municipal Technical College—The Director of Education, Guildhall, Hull (November 3).

EDUCATIONAL PSYCHOLOGIST to work in the Child Guidance Clinic—The Director of Education, Education Office, Town Hall, Bradford (November 7).

SECRETARY to the Research Association of British Rubber Manufacturers—The Acting Director of Research, 103 Lansdowne Road, Croydon (November 8).

REGIUS PROFESSOR OF NATURAL HISTORY in the University of Aberdeen—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (November 22).

SENIOR LECTURER IN ENGINEERING SUBJECTS in the Halesowen County Technical School—The Secretary, Halesowen Higher Education Committee, 21 Gt. Cornbow, Halesowen, Worcestershire.

PSYCHOLOGIST (WOMAN)—The Medical Superintendent, Incorporation of National Institutions for Persons requiring Care and Control, Stoke Park Colony, Stapleton, Bristol.

ASSISTANT EDITOR to assist in the publication of "Monthly Science News"—The British Council, 3 Hanover Street, London, W.1.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Pharmaceutical Society of Great Britain. Centenary Commemoration, April 15, 1941. Pp. ii+84. (London: Pharmaceutical Society of Great Britain.) [910

Institution of Automobile Engineers: Automobile Research Committee. Tenth Annual Report, July 1st, 1940—June 30, 1941. Pp. 32. (London: Institution of Automobile Engineers.) [910

Imperial Agricultural Bureaux. Index to Horticultural Abstracts, Vols. 1–10, 1931–1940. Compiled by D. Akenhead. Pp. iv+160. (East Malling: Imperial Bureau of Horticulture and Plantation Crops.) 25*s*. [910

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 1, No. 8: Reciprocity, Part 6: The Wave Function of the Meson. By Kathleen Sarginson. Pp. 77–92. 1*s*. 3*d*. Vol. 61, Part 1, No. 9: On a Certain Variation of the Distributive Law for a Commutative Algebraic Field. By Abraham Robinsohn. Pp. 93–101. 9*d*. Vol 61, Part 1, No. 10: A New Way of Measuring the Velocity of Light. By Dr. R. A. Houstoun. Pp. 102–114. 1*s*. Section B (Biology). Vol. 61, Part 2, No. 10: Geological Notes on the Stubendorff Mountains, West Spitsbergen. By W. B. Harland. Pp. 119–129+3 plates. 1*s*. 9*d*. Edinburgh and London: Oliver and Boyd.) [1010

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 804, Vol. 239: The Asymptotic Expansion of Integral Functions defined by Taylor Series. By Prof. E. M. Wright. Pp. 217–232. 2*s*. 6*d*. Series B: Biological Sciences. No. 577, Vol. 231: Cones of Extinct Cycadales from the Jurassic Rocks of Yorkshire. By Prof. Tom M. Harris. Pp. 75–98+plates 5–6. 5*s*. 6*d*. (London: Cambridge University Press.) [1310

Edinburgh and East of Scotland College of Agriculture. Calendar for 1941–1942. Pp. 66. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.) [1310

Cork Historical and Archæological Society. Historical and Archæological Papers, No. 2: Three Centuries of Irish Chemists. Edited by Deasmumhan O. Raghallaigh. Pp. iii+30+4 plates. (Dublin: The Talbot Press, Ltd.) 2*s*. 6*d*. [1310

Other Countries

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 28: A Study of the Inheritance in Mean Fibre-length, Fibre-weight per Unit Length of Fibre-Maturity of Cotton. By R. S. Koshal, A. N. Gulati and Dr. N. Ahmad. Pp. 17. (Bombay: Indian Central Cotton Committee.) 8 annas. [310

Cawthron Institute, Nelson, New Zealand. Annual Report, 1940. Pp. 38. (Nelson: Cawthron Institute.) [610

Smithsonian Miscellaneous Collections. Vol. 101, No. 3: Environment and Native Subsistence Economics in the Central Great Plains. By Waldo R. Wedel. (Publication 3639.) Pp. ii+29+5 plates. (Washington, D.C.: Smithsonian Institution.) [610

Indian Lac Research Institute. Bulletin No. 44: Physical Chemistry of Resin Solutions, Part 3: Viscosity of Shellac Solutions in Mixed Solvent. By Santi Ranjan Palit. Pp. 663–674. (Namkum: Indian Lac Research Institute.) [710

Brooklyn Botanic Garden Record. Vol. 30, No. 3: Lilacs in the Brooklyn Botanic Garden, including Classification, Cultivation, Pathology. By Alfred Gundersen. (Guide No. 12.) Pp. 189–224. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) 25 cents. [910

India Meteorological Department. Scientific Notes, Vol. 8, No. 92: Correlation between Frost and the Preceding Meteorological Conditions, Part 2: Jaipur. By Barkat Ali and S. N. Naqvi. Pp. 91–98. 5 annas; 6*d*. Scientific Notes, Vol. 8, No. 93: Heat Radiation from the Atmosphere at Bombay and its Comparison with that at Poona. By R. Narayanaswami. Pp. 99–112. 9 annas; 10*d*. (Delhi: Manager of Publications.) [1010

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 43: A List of some of the More Common Plants of the Desert Areas of Sind, Baluchistan, Rajputana, Kathiawar and South-West Punjab, with their various Local Names as far as Available. Compiled by Y. Ramchandra Rao. Pp. v+45+3 plates. (Delhi: Manager of Publications.) 2.14 rupees; 4*s*. 9*d*. [1010

Year-Book of the Royal Asiatic Society of Bengal for 1940. (Vol. 7, 1941.) Pp. 200. (Calcutta: Royal Asiatic Society of Bengal.) 6.8 rupees. [1310

Records of the Geological Survey of India. Vol. 75, Professional Paper No. 13: A Note on the Bawdwin Mines, Burma. By E. L. G. Clegg. Pp. 14+2 plates. (Calcutta: Geological Survey of India.) 8 annas; 9*d*. [1310

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YOUTH IN SCIENCE

On October 11, five thousand young men and women, representing twenty nations, met at an International Youth Rally for Victory in London. On October 13, Lord Croft, Joint Parliamentary Under-Secretary of State for War, spoke of the necessity of giving youth a bigger place in defence plans. *The Times* of October 13, commenting on the Rally, pointed out that "at the same time [the Rally was] a particular reminder to the young people in this country of the urgency of the present situation and the weight of their responsibility".

These pronouncements are a sign of the times, and all have been inspired by the seriousness of the War in which all of us are involved to a greater or less degree. We agree with *The Times* that youth has a tremendous responsibility to-day, and with Lord Croft that youth deserves a bigger part in our defence plans. But this touches only the fringe of a problem of major importance, touching it as it does in a time of emergency and therefore necessity ; but the problem itself dates back far into history and is as deeply rooted as any other human problem. It is the problem of fitting youth, not in spite of its youthfulness but because of it, into all schemes concerned with human welfare and progress.

The very remark of *The Times* that the Rally served as a "particular reminder to young people in this country" indicates an attitude towards youth which for generations has been all too prevalent—that of giving the younger generation a kind of inferior distinctiveness. The majority of the younger people in this, or any other country, need no more reminding of the gravity of the world situation than the majority of the older generation. It is because of their intelligent awareness that the Rally was held, through their own initiative ; it was not organized by their older colleagues because the latter thought youth needed telling. Youth spoke for itself.

This was clearly realized by Mr. Bevin, who opened the meeting and who emphasized that the Rally pointed the way for a *more imaginative understanding of the capabilities and aspirations of youth* both by leaders of youth organizations and by the political parties. This might well be extended to cover all organizations, including those of the sciences.

The fact that the problems of youth are almost as old as the hills is beside the point. They have always complained of a sense of frustration, of being domineered by those of more mature years, sometimes of being ignored and even of being used as rungs in the ladder to fame by those in authority over them. Their complaints have often proved well founded, but seldom have they been dealt with effectively. The reasons for it are legion, and are sometimes due to thoughtlessness, but sometimes to regrettable arrogance, self-seeking or even selfishness on the part of their older colleagues. Gone are the days when any clear-thinking layman or

more important still, psychologist would subscribe to the view that youth is synonymous with irresponsibility, and that the main characteristic of any man of responsibility must be experience. Experience is, of course, of the utmost importance provided that the person who has had it also has the intelligence and imagination to profit by it. But so often this is not the case. Furthermore, with long-drawn-out experience too often goes susceptibility to hide-bound tradition, loss of initiative and imagination, self-aggrandizement on the basis of *past* achievements and sometimes antipathy to growing youth, who still have those qualities coupled with an emotion peculiar to themselves.

To the older in years may be said "This was, this is, your world"; to youth "This is, this will be, your world". Whose is the greatest responsibility? We see little difference; but too often a distinction is made, to the detriment of youth. More collaboration is needed, thus giving greater encouragement to them. This can best be done by giving them a greater share of responsibility in all walks of life, including that of science, giving them greater representation on organizing, executive, administrative and even advisory bodies.

These questions were raised by several speakers at the recent Conference on Science and World Order, and it is to be hoped that the points made will receive the serious consideration they deserve. Dr. J. E. D. Swann pleaded for a greater utilization of youthful men of science in the war effort and incisively criticized the inefficient utilization of scientific workers in the war effort.

Mr. D. P. Riley pleaded eloquently for the younger generation of scientific workers. "There should be more democracy in science. There should be a place for younger scientists in the councils of scientific planning, in the laboratories and factories themselves, and on national and international committees or commissions. Young scientists, by virtue of their very youth, are endowed with energy, initiative and enthusiasm. They bring a new point of view, that of the younger generation, to bear. Their scientific training has been based, not on the conceptions of nineteenth-century mechanistic physics but on twentieth-century dialectical theories, in which the inter-relation of the various sciences is continually emphasized. Nowadays a chemist must also be a physicist, and a physicist an engineer, and the younger scientists have been trained from the outset in full knowledge of the diverse and powerful modes of attack on any scientific problem. The need for startling ingenuity, for completely new methods, and above all for quick thinking, is very necessary in war-time. More important than all these considerations is the fact that the humbler scientific workers can put forward the point of view of the man actually on the job—actually at the laboratory bench; actually at the production point of scientific discovery.

"The wisdom and conservatism of age and experience could thus be tempered with the effervescence and radicalism of youth. Any tendency on the part of youth to sublime over-confidence would soon be gently and firmly dealt with by their more experienced colleagues. But give youth its chance to help, and not only always at the bottom, but sometimes, dare I say it, almost at the top?

"Let youth as an essential supplement to present official plans put into direct contact with each other rank-and-file scientists in similar fields of science but working in different countries. Let personal contact be established as widely as possible. It would also serve as a valuable basis for international understanding on the cultural level after the War.

"Concerning the peace-time planning of research, it cannot be too often stressed that international co-operation is its very life-blood. In peace-time a greatly increased exchange of younger scientists between the nations is desirable. It is not sufficient to rely on private philanthropy to achieve this, as is largely the case at present, but State funds should be made generously available. These men and women would give to the foreign laboratories in which they would work the different outlook of their home training. They would bring with them different aspects of technique and approach. They would, conversely, learn and take back home with them an understanding of the methods used abroad. All this should occur during the formative years of their lives. Parochialism in science *does* exist and must be combated; this is one way of doing so."

Mrs. S. Neville-Rolfe forcibly pressed before the Conference the same argument, especially from the biological and psychological points of view.

"It is recognized already in military circles (though not always practised) that those trained and experienced in the War of 1914–18 are not the best improvisors of strategy and tactics for a war of dive-bombers and tanks. This principle applies even more strongly to questions which affect the development of man himself.

"The emotionally immature, belonging to a previous generation, with a background of traditional dogma as religion, of *laissez-faire* as social economics, of philanthropic charity as good citizenship, and an idea of the 'equality of man' which ignores biological evidence, are not qualified to govern, or to lead youth in the present world crisis; yet it is they who are in control to-day.

The old in experience and young in mind have ever been outstanding leaders, but the old in mind and years are unable to grasp the new problems or to relate new knowledge to spiritual values. They fear youth and from a mistaken sense of duty they continue to bear burdens beyond their years, and are barring advance.

"It is vital to reach the younger generation, the parents of the future in service and civil life, and gain their intellectual interest and emotional drive behind the idea that man may control and direct to the service of man the forces that he has set in motion. Experience is needed, but so are drive, a new outlook, and faith in man's destiny."

To this must be added the all-important quality of leadership—a character which is not based on experience but is the outcome chiefly of initiative, imagination, determination and faith, and therefore a character no more the prerogative of the older generations than of any others. When a youth shows ability to lead, let him lead. Those of mature age might well offer him the benefit of their longer experience and guide and advise him; but often they ignore him, and sometimes also they usurp his leadership once he has shown the way.

The President of the British Association, intervening after Mr. Riley's remarks at the Conference, expressed his sympathy with the younger scientific investigators; but there are some in authority who do not attempt to exercise such sympathy, at any rate in a practical form. Furthermore, many young men of science ask for more than sympathy; they justly demand more practical recognition as men of science in their own right and not merely as scientific assistants. By keeping them as subordinates until middle age they often lose their capacity and desire for responsibility and initiative; they are sapped of their self-confidence. The President also pointed out that so far as the Division for the Social and Industrial Relations of Science is concerned, youth has played an important part in its development. This is as it should be, especially since the Division itself is a youth. So now let the older institutions and societies and other research organizations follow this example and admit youth to their council chambers. A certain amount of balanced and controlled rejuvenation would not come amiss.

In his message to the International Youth Rally, the Prime Minister, referring to present-day needs, told youth that their place is still in the forefront of battle. H.M. the King, on the other hand, looking to the future, emphasized the gravity of the tasks which the years of reconstruction will lay upon the shoulders of youth. The two go together; they are inseparable. So also should youthful and older men of science march together, their individual status being acknowledged on grounds of scientific achievement and of intellectual, not chronological, age. Youth has a case; at present much of youth is being penalized. Until that unfair imputation is removed (and now is the time to do it), unity of purpose and team work can never be fully developed.

As pointed out in NATURE of October 11, p. 427:

"It seems well worth while investigating how to bring about the necessary unity of feeling, and to arouse sufficient enthusiasm among people agreed intellectually upon the work to be done in order to enable them to pull together as a team. Co-opting more of the younger men in the counsels of science will undoubtedly help much towards this badly needed unity. At present some of the more progressive men of science feel keenly the neglect of their services, especially when older authorities are complaining of having too much to do, too many committees to attend, etc. Once this feeling almost of frustration is eliminated, and younger men are given their rightful place in the advancement of science, a closer unity of feeling will be established."

THE NUTRITION SOCIETY

A NEW scientific society devoted to the study of nutrition, the Nutrition Society, has just come into existence (see NATURE of October 11, p. 433), and an account of its first meeting appears on p. 519 of this issue. Nutritional thought in Great Britain has so far centred around the Biochemical and Physiological Societies, and in recent years the Nutrition Panel of the Society of Chemical Industry has done much to foster interest in food problems. Admirable as these facilities were, they could not keep pace with the increasing scope of nutritional science which now also embraces agriculture, clinical study, practical dietetics and sociological problems. The new Society, while in no sense competing with existing ones, will provide a common meeting-ground

where all aspects of nutrition can be discussed by workers previously separated by the barriers of specialization.

The formation of this body is thus in a measure the expression of the recent rapid development of a science and of the strong position it has always held in Great Britain. In addition, although the atmosphere of war is seldom propitious for the development of learning, it has contributed to the creation of this new academic fellowship. A new spirit is abroad among men of science, who realize that scientific detachment is no longer possible under conditions of total war or after it, and that they have the right and the duty to ensure that the results of their labours are properly used in the cause of humanity. At this time, when the problem of feeding the people is of vital importance to the country, the desire to do something immediately useful is probably foremost in the minds of the members of the new Society. In fact, this spirit had already manifested itself during the year preceding the formation of the Society, in informal exchanges between various workers of views on matters of nutritional importance.

The determination to put to practical use the accumulated nutritional knowledge is evident from the wish of the Society to limit the discussion at its meetings to certain specific topics, rather than to open it to the free presentation of isolated academic papers. Very appropriately the first meeting dealt with the evaluation of nutritional status. Every student of nutrition observes with a sense of shame and frustration the prevalence of malnutrition in this world of plenty. It is staggering to read a pronouncement by the President of the United States of America, that in that country, the richest in the world, undernourishment is widespread and serious. For this unhappy situation the man of science is not wholly blameless, and his attitude of aloofness shares censure with the shortcomings of the politician. In this connexion it is good to hear Mr. Eden express the hope which reflects the spirit of the British Association, that science and statecraft will henceforth march together. Thus might men of science and statesmen inspire and stimulate each other.

A similar desire for the scientific guidance of human affairs has also animated the virile and fruitful National Nutritional Conference for Defense which has recently met in the United States. It has acknowledged frankly that the State machinery in the United States has not given sufficient attention to the nutritive qualities of human foods, that "interest in general has been more in protecting pocket books than health" and that in fact livestock has been given the best parts of many foods.

It cannot be said that matters are any better in Great Britain. While agriculture in this country displays very rightly a keen interest in the forage and fodder value of its products, it is little, if at all, concerned with their value in human nutrition. The value of agricultural produce as human food is rarely considered much before the stage of actual consumption; previous to that, in the stage of production and distribution, it is just a marketable commodity. Much has been heard about the marriage of health and agriculture, but it is only with scientific planning that this union will bear fruits of high nutritive value.

With the formation of the new Society a hope for the future is raised in that workers in nutrition from all spheres will get together and pool their knowledge, plan their work on a practical basis, and combine to see that the greatest possible benefit to mankind is derived from the results. It takes little imagination to foresee that the proper nutrition of the people will form the foundation of future health programmes, and here the Nutrition Society will doubtless supply much creative planning. Many data are already to hand and it will be for the Society to see that such information is better utilized in the future.

In the meantime nutrition workers in Great Britain, going about their immediate war-time tasks, will derive inspiration and support from its meetings. When the time comes some and probably many of them will take an active part in the relief of the widespread misery and starvation which Nazi rule has brought on the subjugated peoples. Ample opportunities for humanitarian service will present themselves to the Nutrition Society which, we are informed, has had the happy thought of making early contact with its American counterpart —the American Institute of Nutrition—and with leading students of nutrition in that country. It is to be hoped that they will join hands in this work of reconstruction.

It is auspicious and fitting that Sir John Orr should have been called to be the first chairman of the Society. One of the few to realize the seriousness of the nutritional problems of Great Britain, he has now for many years, with pertinacity and courage, called for a constructive policy for the scientific feeding of the people. His voice has for too long been unheeded, but things have changed and his guidance in matters of nutritional planning is now frankly acknowledged on both sides of the Atlantic. Further, the Society may be proud that it has been ushered into being by Sir Frederick Gowland Hopkins, the doyen of nutritional science, whose great work will always be, in the future, as in the past, an inspiration to all who labour in this field.

FOUNDATIONS OF WORLD UNITY

The Bases of a World Commonwealth
By C. B. Fawcett. Pp. xi+167. (London: Watts and Co., Ltd., 1941.) 7*s*. 6*d*. net.

LESS ambitious than some of the volumes and pamphlets which in the last year or two have discussed the problem of world order after the War, Prof. C. B. Fawcett's book is likely to commend itself particularly to scientific workers. It contains no constitution for a world State or even a plan for the establishment of world unity. It is concerned with the foundations on which a world order can be based rather than with the manner in which the building is to be erected. The approach has the same scientific character as that which distinguished Prof. J. T. Shotwell's "The Renunciation of War as an Instrument of National Policy" a decade and a half ago.

Prof. Fawcett's main thesis is that the developments of applied science have now made it impossible for any part of the civilized world to remain isolated from the rest, or to be self-sufficient in all the natural resources needed by a modern civilized community. These developments and those in the means of communication have linked the world into a single economic area. The dominant trend of Western civilization is towards ever larger political groupings, and the ultimate goal must be the union of the world into some form of State. The choice is between a commonwealth of free peoples or an empire dominated by the finally successful conquerors.

The major part of Prof. Fawcett's book is devoted to a critical analysis of the possible bases of world unity. These are necessarily twofold—material and moral. His second chapter, in which he discusses the geographical basis, is the most distinctive in the book and its close analysis of the distribution of the chief natural resources and of the routes by which they may be brought together indicates that there are only a few limited and definable areas which can be the bases of world power. Of these the European and American major human regions are the chief. Together they can determine the form and the establishment of world unity, but a division of the world into three or four super-States, each based on one of the major human regions, would be as likely to postpone as to advance the establishment of a world commonwealth.

This geographical analysis stresses the importance of attempting to overstep from the start the limits of any one of these major regions and to include at least parts of all or most of them, although the chief focal area must form the starting-point. While, however, in spite of its extreme political fragmentation, the physical geography of Europe no longer offers any serious obstacle to its effective economic and political unification, the moral bases are equally important. A voluntary union can be made only on the basis of agreed principles. No union can endure unless a majority of the active citizens in each participating State are agreed upon the fundamental principles on which the union is to be based. Prof. Fawcett argues that the only conceivable voluntary union of European States and peoples would be one based on the democracies, but the ten democratic States of Europe form an insufficient basis for a European union until the German people have become free men and women through a process of re-education. There is no hope, even for Europe itself, in a United States of Europe limited to Europe.

From this analysis and a further closer examination of the United States and the British Commonwealth, including the problems presented by the dependencies and by the coloured peoples, Prof. Fawcett concludes first, that while the peoples of the British Commonwealth may move towards closer co-operation with other free peoples, particularly with the United States of America, it is not practical politics to propose that Great Britain should become a member of any merely European union or of any union which does not include the other dominions. The power to initiate a new world in which the democratic ideals can be realized lies, he concludes, finally with Anglo-American co-operation. The British and the American Commonwealths alone are in a position to strike effectively for freedom, and on whether they accept that responsibility and seize their opportunity depends whether their ideals and way of life shall prevail or perish. The world can no longer endure half slave and half free, and only the British and American Commonwealths can provide the power to enforce the law or initiate the framework of law and order essential for freedom and peace.

In his main argument Prof. Fawcett makes many significant observations. He is inclined to stress the importance of a common language and looks to Esperanto as an essential second language if the peoples of the world are to become united as free peoples. He notes the backwardness of American citizens in realizing their existing imperial responsibilities and the tardiness with which the essential unity of the civilized world is

yet realized in any country. He comments on the greater ease of real community of thought across the Atlantic than between north and south on either side of it, and he recognizes the urgency of removing the linked evils of poverty, malnutrition and ignorance in the dependencies, as well as the impossibility of achieving world unity if co-operation is limited to any exclusive groupings of race, religion or colour.

What is significant at the present time is that Prof. Fawcett's analysis leads him to much the same conclusion that Streit has reached in his "Union Now With Britain", Lionel Curtius in his "Decision" or Julian Huxley in his "Democracy Marches". This concensus of opinion regarding the closest co-operation between the United States and the British Commonwealth is far more important at the moment than the exact form which that co-operation takes. Unless the foundations are sound the structure may fail once more at the first real test.

The immediate task in the establishment of world order is that of securing the widest possible active support for this conception of the essential unity of the civilized world and for the first measures required for the formation of a union based not on force but on community of ideals and interests. The significance of the Churchill–Roosevelt declaration lies more in its contribution to that task of education than in the expression of any intrinsic advance in thought. It indicates rather the extent to which action on a common policy and common principles by the United States and Great Britain has become practical politics. Similarly, Prof. Fawcett's admirable study is chiefly of value for its contribution to this task of education and for the evidence it affords that Anglo-American co-operation is already taking shape in forms which hold out the best hope of establishing for all nations a world order embodying the ideals of freedom and justice and respect for human rights and personality which are the common heritage of the English-speaking race.

R. BRIGHTMAN.

PATHOLOGY OF GRASSLAND

Diseases of British Grasses and Herbage Legumes

By Kathleen Sampson and Dr. J. H. Western. (Issued for the Authors by the British Mycological Society.) Pp. vii + 85 + 8 plates. (Cambridge: At the University Press, 1941.) 5*s*. net.

GRASS is one of the few crops which is still grown under semi-natural conditions; even the best-managed grassland still remains an association of plants, as opposed to the pure culture of most other crops. It is no idle coincidence that the pathology of grassland has been for so long neglected. The spread of diseases and pests among a mixed population is neither so rapid nor so extensive as in populations of a single species; the importance of grass diseases first came to be recognized when grasses were grown in pure culture for seed production. The practice of re-seeding pastures, and the wider use of temporary leys, strenuously advocated of recent years by the Welsh Plant Breeding Station, implies the improvement of grass strains for pasture and for hay production by selection and plant breeding. Among the difficulties of this work, the incidence of disease is by no means the least. The appearance of a bulletin on "Diseases of British Grasses and Herbage Legumes", by Miss Sampson and Dr. J. H. Western, is a welcome reminder that this aspect of the drive for grassland improvement at the Welsh Plant Breeding Station has not been neglected. The senior author, Miss Sampson, is well known for her researches on diseases of grasses and herbage plants, and this bulletin is the outcome of some twenty years investigation at the Welsh Plant Breeding Station.

The bulletin, to which a foreword is contributed by Sir George Stapledon, deals both with the individual diseases of grass species and of herbage legumes, respectively, and with the collective diseases of turf, such as snow mould, red thread, etc. It is intended, by its technical character, more for the professional plant pathologist and the agricultural adviser than for the actual grower. No exception can be taken to the mycological treatment of the different diseases, and the excellent plates are a welcome supplement to the text-figures for purposes of diagnosis.

The recommendations for control make it clear that much research work still remains to be done before the position can be regarded as satisfactory by the seed grower. It is surprising to find, for example, that the life-cycle of so well-known a parasite as *Epichloe typhina*, the cause of choke, is still partially obscure. Again, the section on individual diseases of grasses contains no reference to any root disease, though at least one root-infecting fungus, *Ophiobolus graminis*, is known to be widely distributed on the roots of grass. Whilst this fungus has so far chiefly attracted

attention on cereals, grassland is the source of the disease, and it seems possible that variation in susceptibility of individual grass species to attack by *O. graminis* may at times modify herbage composition. Again, there is no mention of any virus disease of grasses, and only half a page is devoted to virus diseases of herbage legumes. These discrepancies may be reduced by further research; in the meantime, the authors are to be congratulated on the production of a most timely and useful publication.

S. D. Garrett.

ECONOMIC GEOGRAPHY

Economic Geography
A Regional Survey. By Prof. R. H. Whitbeck and Prof. V. C. Finch. (McGraw-Hill Series in Geography.) Fourth edition. Pp. xii+647. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 24*s*. 6*d*.

This is the fourth edition of a well-known text-book, produced under the limitations of war-time. These have compelled the author to omit many details of which up-to-date statistical information is not available, and thereby given more prominence to the permanent factors of geography in comparison with the now obviously less stable political limits.

The short introduction on the nature of economic geography states the author's views. It should be read in conjunction with the companion text-book "Elements of Geography" by Finch and Trewartha, in the same series. The approaches are defined as (1) regional, in which one attempts to synthesize the factors of the geography of a part of the earth, and (2) topical, in which the aim is to study some one aspect over the whole earth. In this book the method is that of topical studies within very broad divisions. Because of the importance of political limits in economic geography, particularly in a time of economic nationalism, these divisions are mainly determined by political rather than natural boundaries, and the subtitle of "A Regional Survey" is scarcely justified.

The book is in two parts: (1) the United States and Canada, which the author sometimes calls Anglo-America, and (2) the rest of the world. Part 1 is slightly the longer. Less than a quarter of the space, 140 out of 647 pages, is given to Europe, including all the Mediterranean lands and the U.S.S.R.; and only nineteen pages are given directly to the British Isles. These proportions reflect the world as seen from the Middle West of the United States.

The book is essentially a sound text for college students. Present conditions have made it difficult to get up-to-date statistics; hence there are few in the text, which makes the book more readable. A few statistical tables are given in appendixes; nearly all these can be got in such reference books as the "Statesman's Yearbook"; and it is difficult to see why they should be reprinted here, since many of them are soon out of date and students likely to use the book should have access to, and be trained to use, reference books.

In two items the book could be made more useful. The many references to the diagrams should be by page as well as by number of the figure, since it is much easier to find a page; and there should be a list of the 315 illustrations. For example, there is a diagram-map of world wheat-growing on p. 47; it is frequently referred to afterwards as Fig. 17; but it does not appear in the index or in any list. The present reader has found it worthwhile to insert many cross references, especially to the figures.

Errors are few, as may be expected in a fourth edition. There is the common Middlesborough for Middlesbrough, and also Sidney for Sydney (p. 607). The discovery of gold in Australia was made in 1851, not 1857 (p. 608). There are similarly few omissions; but it may be noted that there is no reference to wind among the sources of power, nor to the obtaining of oil from coal, both of which have some importance in parts of Europe. Hair is not included among textile materials; though there is reference to mohair in the sections on Turkey and South Africa. At the end of each chapter is a short list of selected references for further reading; these are wholly in English, and are mainly Government publications and text-books. Only eight of the many distribution diagram-maps are world maps; more would be useful to show the distribution, and illustrate the transport routes, of such commodities as mineral oil, coal, etc. Many of the map-diagrams are from the excellent series produced by the U.S. Departments of Agriculture and Commerce. But far too many of the statistical diagrams are undated.

For the study of the economic geography of North America this is likely to maintain its position as a standard text. For the rest of the world students must still look elsewhere. Here and there are sentences referring to problems of the economic utilization of natural resources, which is one of the main themes of economic geography; but this is not a study of the philosophy of the subject. The authors set out to produce a good text-book, and have succeeded.

C. B. Fawcett.

TERCENTENARY OF COMENIUS

ON October 24, the tercentenary of the visit to England in 1641 of Jan Amos Komensky (Comenius), the famous writer on education, was observed in the Senate House of the University of Cambridge.

The official representatives were as follows: Government of Czechoslovakia, Dr. E. Benes, president; Government of the U.S.S.R., M. Maisky, ambassador; Government of the Netherlands, M. Bolkestein, minister of education; Government of Poland, Count Racyński, foreign minister and ambassador; Government of Yugoslavia, M. Milanović, under-secretary of state for foreign affairs; Government of Sweden; the Board of Education, Dr. R. Fitzgibbon Young; the Royal Society, Sir Henry Dale, Sir William Bragg, Sir Frederick Gowland Hopkins, Sir Charles Sherrington; the Moravian Church, The Right Rev. C. H. Shaine; the British Council, Prof. B. Ifor Evans.

In his opening discourse Dr. Benes, President of Czechoslovakia, described Comenius's plans for peace leagues and his place in history as a great European. This pastor, later bishop of the Moravian Brethren, a brilliant pioneer in educational methods, stood in his breadth of views as a veritable giant above his contemporaries. President Benes pointed out that the position of the Czech people, surrounded as they have been for a thousand years by other peoples in the heart of Europe, has disposed them to a natural pan-Europeanism. The necessity of being on good terms with Germans to the north, Latins to the west, Slavs to the east, and the Balkans to the south, early implanted in their minds ideals of internationalism. President Benes emphasized the happy nature of the stimulus between English and Czech culture which occurred when in 1641 Comenius was invited by Parliament to visit Great Britain and prepare plans for the remodelling of education and the establishment of a "Pansophic College".

Comenius's place as an educator was next dealt with in a brilliant and moving speech by Mr. J. L. Paton, formerly high master of Manchester Grammar School and later president of University College, Newfoundland. Comenius represented all the ideas which have successfully triumphed in modern education; he was against class distinctions in the school, he was in favour of the education of women, he wanted to introduce science, music and handwork at the expense of the Latin grammar which at that time was universally learnt by heart, he desired schools to be happy workshops of humanity (in his own words) rather than the torture-chambers of youth that they were. In the "Didactica Magna", he summarized his basic belief, that man is a rational creature situated by God among visible creatures, the natures and properties of which he must of necessity know. Hence Comenius's interest in science—"the new or experimental philosophy"—arose out of his interest in education, and that in turn sprang from his theoretical position as one of the great Christian humanists.

Comenius never felt that science would clash with revelation: "Christ", he said, "called himself not Tradition, but Truth itself." Though he himself was, like most of his contemporaries, a great believer in the literal truth of the Scriptures, he nevertheless, like Sir Thomas Browne, insisted that Christians ought to pay at least equal attention to that other bible, Nature, "that open and publick manuscript which lies expans'd unto the eyes of all".

Prof. J. D. Bernal, continuing Mr. Paton's theme in the direction of the sciences, pointed out that though Comenius made no scientific discoveries himself, he brought it about by his new ideas on education that men should arise who could make scientific discoveries. Comenius was a man very comparable with Boyle, who also combined a passionate belief in the growth of natural science with a universalism which desired the propagation of the Gospel in those far parts of the world with which the voyages of exploration had made Europeans familiar.

Like Boyle, Comenius was associated with New England, and was even invited to Harvard College. This Christian universalism was the mainspring of the interest of such men as Comenius and Wilkins in a universal language as well as in universally applicable methods of education, which should deal with things and actions, not words and ideas. From the *Unitas Fratrum* (the Moravian Brethren) came the ideas of *unitas* and *communitas* which dissolved the secrecy of the alchemists and astrologers into the liquid homogeneity of a higher level of international collaboration in science, in religion and in education. We rightly commemorate Comenius, the spiritual father of the "Invisible College", and the patron saint of those who are conscious of the social relations and function of science.

The proceedings were concluded by Prof. Ernest Barker, who in a charming discourse referred to many other points of Anglo-Czech cultural contact, and expounded the great debt which all Europe owes to Bohemia, Moravia and Slovakia.

EVALUATION OF NUTRITIONAL STATES

THE newly formed Nutrition Society began its active life at Cambridge on Saturday, October 18, with a symposium on "The Evaluation of Nutritional States". The audience included the president of the Royal College of Physicians, Lord Dawson, Prof. E. J. Bigwood, professor of biological chemistry in the University of Brussels, Prof. J. Preston Maxwell and the heads of a large number of biochemical and other laboratories. Messages of good-will had been received from various British scientific societies and from research workers in Britain and America.

In the morning, the chair was taken by Sir Charles Martin, who gave a brief history of the formation of the Society and, before calling on Sir Frederick Hopkins for his introductory address, paid a tribute to his success in ending the complacent attitude of the first years of the nineteenth century. Sir Frederick outlined the changes in the outlook of the science of nutrition during the fifty years that have passed since he gave his first lectures on nutrition.

The first session dealt with the assessment of the level of nutrition in man. Dr. Leslie Harris claimed that the nutritional state cannot be assessed satisfactorily without laboratory methods. Clinical methods suffer from lack of definite standards, and food deficiencies may be present without clinical evidence. He gave examples of tests for deficiency of several vitamins and dealt more fully with the saturation test for vitamin C. Examples were given of the response to the test by well-fed and slum children, and of the effects of the War. He discussed the causes of food deficiencies in Great Britain, and stressed the frequency with which sick persons are given inadequate diets.

Dr. H. M. Sinclair, who followed, questioned the validity of the assumptions on which the saturation tests are based. He preferred to base conclusions on evidence of failure of function; for example, the corneal changes, visible with the slit-lamp, due to deficiency of vitamin A or riboflavin. These functional changes may be due to deficiency of more than one nutrient. He discussed some surveys now being made in which the results of tests are being correlated with the diet.

Drs. J. Yudkin and G. W. Robertson discussed the incidence of lowered dark adaptation and the effects of treatment with vitamin A or carotene. They have found that in some factories in the Midlands, less than 50 per cent of workers between 15 and 20 years of age have good dark adaptation.

In the afternoon, with Sir Joseph Barcroft in the chair, the subject was clinical signs of dietary deficiency. Dr. B. S. Platt showed a remarkable series of photographs to illustrate the effects of deficiencies in China and Africa. He stressed the incidence of mild wet beriberi; in some factories in Shanghai, half the workers had œdema of the ankles. He pointed out the relation of infection of the skin and mouth to vitamin deficiency and concluded by showing photographs of two groups of African workers, one ill-fed, listless and silent, the other well-fed, vigorous and noisy: the aim of the science of nutrition should be the cheerful vigour of the second group.

Dr. R. H. Dobbs enumerated various methods used in the assessment of the nutrition of children, particularly those of von Pirquet.

Mr. W. C. Nixon argued that pregnancy imposes a special strain that brings out latent deficiencies of nutrition. For example, among a poor Chinese population, vitamin B_1 deficiency was endemic. Frank beriberi appeared late in pregnancy, although during the earlier months the women suffered from cramps and vomiting. Œdema of the ankles might be present for several weeks before the onset of severe beriberi. Much of the illness associated with pregnancy may be due to deficient food.

The discussion of the nutrition of farm animals was opened by Dr. C. Crowther. He pointed out the differences in the aims and methods of the study of the nutrition of human beings and animals. The estimation of the nutritive value of the food of farm animals is much complicated by the fact that cellulose cannot be neglected. The calculation of the energy value of food has done more than anything else to improve the scientific control of feeding. Farm animals are not liable to suffer from vitamin deficiency unless they are confined and fed on concentrates. Dr. Crowther insisted on the interaction between the various constituents of a diet; it is not possible to regard the effects of constituents as merely additive.

Dr. H. H. Green gave examples of deficiency diseases in farm animals, including deficiency of trace elements. Dr. John Hammond showed a series of diagrams illustrating the effect of underfeeding mother and offspring on the growth and physical conformation of the offspring. The physique is permanently affected by a low level of feeding during the early months of growth.

Unfortunately, more than one of the speakers appeared not to have prepared his address and wasted the time of the meeting while he sought for his thoughts, or words in which to express them, and/or repeated himself. Open discussion had to be left until after tea. Although many members had left, there was a valuable exchange of views.

THE MECHANICAL PROPERTIES OF SOLIDS*

By PROF. E. N. DA C. ANDRADE, F.R.S.

STRENGTH OF SOLIDS: GENERAL

WHILE the specific heat, melting point and many other physical constants of a crystal are definite for any defined chemical composition, the mechanical strength may vary widely from specimen to specimen and depends markedly upon previous history. The existence of structure-sensitive properties in crystals shows that actual crystals cannot consist of atoms or molecules arranged in the perfect pattern contemplated by the mathematician nor can they be structures in thermodynamic equilibrium. If crystals were perfect they would all have the same properties if of the same material; similarly, if they were in thermodynamic equilibrium, they would eventually, from whatever arrangement they started, reach a final arrangement corresponding to the least free energy, and this arrangement, and consequently the mechanical properties, would always be the same. All crystals as usually dealt with must, then, be imperfect, although the possibility of preparing a perfect crystal must not be definitely excluded.

Under tension a theoretically perfect crystal should show perfect elasticity up to a high strain and have a sharp breaking point. Under shear stress it should likewise have a wide range of perfect elasticity, and if the stress exceed a certain value unlimited glide should take place. In neither case is plastic yield and work hardening, such as is actually observed with metals, to be anticipated. We can, from quite general considerations based upon the energy required to form a new surface, make a rough estimate of the tensile strength to be expected in the case of a perfect crystal, and find that for the strongest metals this hould be about 360 kilobars (=2,300 tons weight per sq. in.), which is about forty times the tensile strength of the toughest metal. If we take the yield-point, instead of the tensile strength for comparison with the theoretical value, the discrepancy is even greater. Similar calculations can be carried out for the theoretical shear strength, and give a value of about 130 kilobars, some forty times that observed for steel. Thus even the toughest metals show much less than the theoretical strength.

Ordinary metals, however, are polycrystalline; it may be suggested that for comparison with theory it would be fairer, perhaps, to consider a single crystal. Let us take rock salt as an example, for it is a simple face-centred cubic crystal composed of alternate positive and negative ions, for which the mathematicians can carry out exact calculations, of, for example, the theoretical strength. For rock salt this works out to be 20 kilobars and rupture should theoretically be preceded by an elastic extension of 14 per cent. The actual breaking strength of rock salt under tension is, however, about 20 bars, that is, about one thousandth of what it should be. Rock salt does give brittle fracture, with very small extension at ordinary temperatures, although at higher temperatures, about 600° C., it shows plastic behaviour.

A perfect ionic crystal of a type which is for most purposes well understood theoretically is, then, in practice much too weak and has much too small an elastic region. Let us look at its behaviour in a little more detail. To examine a transparent crystal we have an agent which we cannot use for metals—polarized light. A cubic crystal such as rock salt has, in an unstrained condition, no effect on such light; any strain that makes the crystal depart from its precise cubic structure causes it, however, to become doubly refracting. Obreimow and Schubnikow[1] loaded a crystal of rock salt in a beam of polarized light; at a low stress, of about 8 bars, bright streaks appeared along two directions at right angles, which were the traces of (110) planes. These lines did not appear as soon as the stress was applied, but arose spontaneously some 20 seconds later. As the stress was increased the bright lines increased in number, but appeared always in the same crystallographic directions. Surface marks also appear in the same direction if the crystal undergoes plastic extension at high temperature. The crystal shows permanent slip on certain crystallographic planes, but polarized light shows that its crystalline perfection has been destroyed along these planes. The glide-planes were established much earlier in metals, but I quote rock salt first because of the ease with which this latter point can be established. The same thing has been shown with other transparent crystals, for example, potassium halides.

Let us see if we fare any better as regards strength if we take a non-crystalline substance, say glass. The surface tensions of molten glasses are round about 150 dynes per centimetre, which gives theoretical strength of the order 100 kilobars. The actual strength of ordinary glass fibres, which give brittle fracture at room temperatures, is from

*Abridged from the Forty-seventh James Forrest Lecture of the Institution of Civil Engineers, delivered on April 29.

300 to 900 bars—less than one hundredth of what it should be. Here, however, we meet a curious fact of great importance for our subject: freshly drawn glass fibres, of hard glass, are very much stronger than old fibres, of the same glass, but gradually lose their strength as time goes on and come down to a steady value. Touching or handling the fresh fibres weakens them. A. A. Griffith[2], who has carried out fundamental work on this subject, assumes that the cause of the weakening is the formation of invisible surface cracks, which are absent in a fresh fire-drawn material. The breaking strength will depend upon the depth of the crack and the radius of curvature at the end: the greater the former and the smaller the latter, the higher the local stress and the weaker the material. There is a limit to the radius of curvature: it cannot be less than something of the order of the inter-atomic distance. If we assume a reasonable value we can work out the depth of the crack needed to give the observed strength, and it comes out about 1 or 2μ, say twice the wave-length of visible light. Of course if we have threads of this order of diameter we cannot have cracks of this depth, and very fine threads are, in fact, much stronger per unit cross-section than large threads. The variations of stress, due to cooling, necessary for the formation of the cracks, probably cannot be established in such fine threads.

These cracks are no longer a mere hypothesis. Mr. Tsien and I[3] found that attack by sodium vapour (but not by hydrofluoric acid) would develop the cracks and make them visible. On freshly drawn hard glass tube, no, or very few, cracks could be detected; on the same tube, when a day or two old, many cracks were made visible. They ran transverse to the direction of drawing of the glass rod or tube, as they should. Various controls established that we were not dealing with a spurious phenomenon. Dr. Martindale and I[4] also found that when very thin films of gold and silver were heated to about 300° C. on glass surfaces minute crystallites formed up in lines, which were in general parallel. These lines are not caused by visible scratches but are attributable to minute surface cracks. I may add that just before the War, I succeeded in showing the minute surface cracks in hard glass by a special type of illumination[5].

An experiment of Orowan's[6] is instructive in this connexion. If a strip of mica be loaded by means of parallel metal clamps, extended across the whole strip, so that the edges are stressed, we find a maximum strength of about 3 kilobars, approximately that of wrought iron and very much in excess of that of glass and of rock salt. The flat faces of mica are very perfect, and show no lines of minute crystallites when metal films are heated on them. The cut edges have, of course, no such perfection. By using special clamps, gripping the sheet near the middle only, stresses at these edges can be avoided. For a mica sheet loaded in this way the strength goes up to 32 kilobars, more than ten times that with the other method of loading, and much in excess of that of the best constructional steel. The prejudicial effect of trivial and invisible cracks at the cut edge is clear.

There are many industrial examples of the importance of the avoidance of surface cracks. Toughened glass is prepared by rapidly cooling the surface of the slabs while the interior is still molten. When the internal part solidifies and cools, the shrinkage pulls the surface into a state of compression, which prevents the formation of cracks. The glazing of industrial porcelain, for insulators and such like, is also instructive in this connexion. If the object is to be strong the glaze must have a coefficient of thermal expansion lower than that of the porcelain body. When the cooling takes place after glazing, the greater shrinkage of the body pulls the surface glaze into a state of compression. If a glaze with a higher coefficient of expansion be used, the strength of the porcelain is less than that of the unglazed body. The swelling of the metal surface by the process of nitriding may also act as a talisman against fatigue cracks, which usually start at the surface.

Glide in Metal Single Crystals

At first it might seem possible that the failure of a piece of ordinary polycrystalline metal to show the properties of a perfect crystal could be attributed to the fact that it is not a single crystal, but an aggregate of small crystals with their axes in all directions. The crystal boundaries might play an important part in determining the metallic properties. We shall see that they do, but scarcely in the way to be anticipated. In any event, it is clear that if we desire to understand metallic behaviour we must first understand the behaviour of a single crystal of metal.

Metal single crystals in the form of wires and rods can be prepared in a variety of ways and exhibit many peculiar properties. In the first place they are not, as might be expected, very strong but they are very soft. They also show very remarkable strain hardening. A copper crystal rod half an inch in diameter behaves like lead at first manipulation; it can be very easily bent in the hands, but becomes progressively harder to deform. It takes a very strong man to bend back to its original form such a rod that has once been deformed into a semicircle. Brittle behaviour is not unknown in single crystal specimens (bismuth

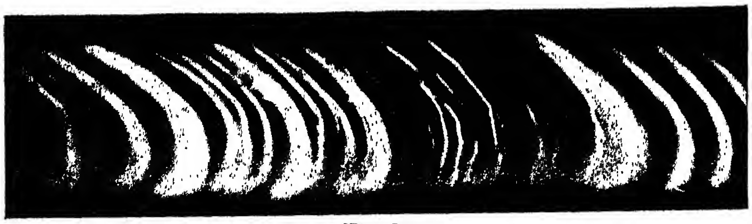

Fig. 1.

SLIP PLANES OF MOLYBDENUM AT 1,500° C. FROM ANDRADE AND CHOW, *Proc. Roy. Soc.*, A, **175**, 290 (1940).

Fig. 2.

SLIP PLANE OF MOLYBDENUM AT 2,000° C. FROM ANDRADE AND CHOW, *Proc. Roy. Soc.*, A, **175**, 290 (1940).

crystals, for example, show brittle fracture at low temperature), but it is not typical.

Remarkable properties of single crystal wires can be exhibited by simply subjecting them to tension. On slight extension a number of parallel markings appear on the surface and as elongation proceeds these become, in general, more and more marked: in some cases the number increases. The wire retains practically its full diameter in one direction and thins in a direction more or less normal to this, so that in the case of wires that can be pulled to several times their original length, such as, for example, cadmium wires, the original cylinder becomes a thin ribbon. As the result of the work of Polanyi, Schmidt, G. I. Taylor, and others this behaviour has been expressed in terms of the geometry of the crystal[7]. The slip takes place preferentially on certain types of crystal planes and in certain definite crystallographic directions—the glide planes and glide directions.

If slip took place equally readily on all parallel atomic planes the crystal surface would, of course, be as smooth after extension as it is before extension. What takes place, however, is a preferential glide in the neighbourhood of certain planes, the so-called slip planes, spaced at more or less regular intervals, so that the crystal appears to slip in parallel slices or slabs. This produces the remarkable stepped appearance characteristic of crystal wires that have been much extended. In general the spacing of the slip planes becomes wider and wider as the temperature is raised. With molybdenum at 1,500° C., for example, the coarse appearance of the slip packets is very striking, as seen in Fig. 1; with molybdenum at 2,000° C. the slip may take place all at one plane as shown in Fig. 2. This may be compared with the appearance of cadmium at room temperature (Fig. 3). It has been suggested that the choice of the particular region where marked glide takes place may be due to local impurities, but experiments carried out in my laboratory with wires of exceedingly pure solid mercury (the impurity was probably about 1 in a hundred million), show that this cannot be so. The slip bands are very fine and close, as shown in Fig. 4. The whole question of the formation of these bands, which represent a kind of local avalanches, is a complicated one.

STRENGTH OF METAL SINGLE CRYSTALS

When we turn to the question of strength, we enter a very difficult field. The simplest case is that of brittle fracture. The determining factor here is the tension normal to the plane of rupture.

Fig. 3.

SLIP PLANES OF CADMIUM AT ROOM TEMPERATURE. FROM ANDRADE AND ROSCOE, *Proc. Phys. Soc.*, **49**, 152 (1937)

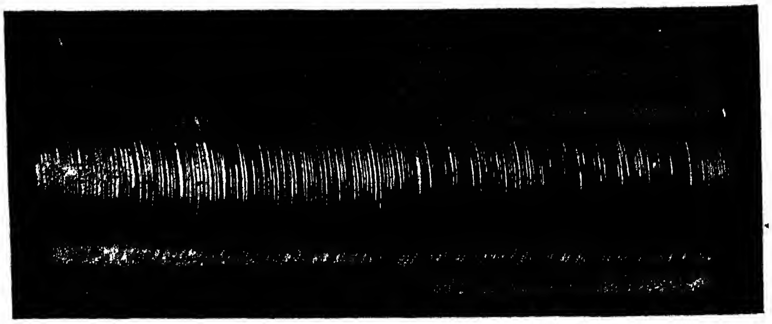

Fig. 4.

SLIP BANDS OF PURE MERCURY. FROM GREENLAND, *Proc. Roy. Soc.*, A, **163**, 28 (1937).

If the critical tension N which leads to fracture, the critical shear stress S, and the crystal structure are such that a crystal can be so disposed that the stress resolved normal to the plane of rupture is N while the stress resolved along the glide direction is less than S, fracture without glide can take place. With crystals of hexagonal structure it is possible to realize these conditions, and we find that the recorded critical tensions run from 120 to 18 bars with different metals and different temperatures; for example, 20 bars for the basal plane of zinc at $-185°$ C. This compares with 1·3 kilobar for polycrystalline zinc and a theoretical value of some 100 kilobars.

Brittle fracture is, however, rather the exception than the rule. For metals of cubic structure, where there are many alternative equivalent glide planes, the values of N and S and the geometry of the crystal apparently prohibit it. Even with hexagonal metals, glide is the normal occurrence.

The inception of glide, which takes place by sudden avalanche-like slipping in the neighbourhood of isolated planes, occurs at very low stresses, of the order of 20 bars, much less than one thousandth of the theoretical strength. If we wish to consider rupture, we are confronted with a variety of processes that can take place before actual fracture. We have in general a progressive hardening as movement proceeds, but quite often, especially with hexagonal metals, we ultimately get twinning, leading to glide on a fresh set of planes, at a new inclination, which is followed by fracture. In the case of hexagonal metals, where brittle fracture can be brought about by suitable geometrical conditions, the glide which takes place before rupture can either raise or lower the breaking strength, according to temperature. For these metals the breaking strength is, however, of the same order as that in the case of brittle fracture. In the case of certain metals, glide can lead to very great hardening, so that stresses of nearly a hundred times the critical shear stress can be supported, but here, as will be pointed out, the result of glide is that the specimen has lost much of its monocrystalline character. It remains true that a single crystal is very soft.

Before we look at any further facts, it may be well to consider the attempts that have been made to explain theoretically the outstanding difficulties offered by the softness of the crystals—their proneness to glide under very small shear stresses. The atoms are bound in their places by interatomic forces, the potential of the field of force having a minimum at the position where the atom is in equilibrium. If an atom is moved from this position the force tends to restore it; the case is similar to that of a table covered with a regular network of depressions, with a ball lying in each depression. Now consider the force required to move all the balls at once in a given direction, so that each rises out of its hole and falls into the next hole in that direction. It will clearly be the force required to move a single ball multiplied by the number of balls, and this is equally true when a ball lies in every hole and when a few vacant holes are included in the array. The low value of the critical shear stress cannot be accounted for on the basis of the simultaneous movement of all atoms in a glide plane.

The position may perhaps be clarified by considering simply a row of cylinders touching one another, with a second row of cylinders resting on them, as in a model which I have constructed. The force required to move one whole row over the other is considerable. Suppose, however, that the number of cylinders in the upper row is one or two fewer than that in the lower row. A place of non-fit, or dislocation, is arranged at one end of the row, towards the right, there being four in the upper row to five in the lower row here. To make the model resemble the atomic case all the upper cylinders in the model are connected by a long strip of elastic band. If we now run our hand over the upper row, from right to left, which is equivalent to imposing a force from left to right on the lower row, it is easy to make this dislocation travel along: at any given moment we are only moving a few cylinders through the periodic field of gravitational potential. After the dislocation has travelled, however, every cylinder has moved one place and the whole row has been displaced relatively to that below, although at any given moment we were only moving a few cylinders.

The fact that glide takes place at shear stresses so far below the theoretical value shows that a whole sheet of atoms cannot travel at once over a neighbouring sheet. The conception of the glide mechanism, which we owe to Polanyi, G. I. Taylor and Orowan, postulates that in the metal crystal there are small localities in which the crystal is out of joint, places of misfit something like that represented very crudely in our model. Under shear the whole crystal plane does not move by one atomic spacing simultaneously: rather the misfit runs easily through the crystal, leaving in its wake atoms properly spaced. In a sense, then, the weakness of the crystal is due to imperfections which are somehow inherent in the structure. A perfect crystal might have theoretical strength, but probably no such thing exists.

There is considerable doubt and diversity of opinion as to the origin and end of the dislocations. G. I. Taylor[8], for example, when proposing a very suggestive but rather formal two-dimensional model, considers that the stress produces in the metal crystal a multitude of regularly spaced

dislocations, which run a certain distance and then end their course in flaws which he postulates. It is difficult to see on this picture anything to prevent the effect being reversible, which it certainly is not. Orowan considers that the dislocations are created at microscopic 'Griffiths cracks', sharp notches where the stress has values considerably above the average, and that they run right across the specimen. W. G. Burgers and Kochendörfer believe that the crystal is built up of small blocks in which the orientation of the crystal structure differs slightly from block to block, for which there is X-ray evidence with rock salt and some other crystals. The dislocations are then supposed to start from the boundary of the blocks. There is no space to discuss details: the general conception of a travelling misfit seems, however, to be the proper basis for any theory of glide.

Another fruitful conception is that of cracks, notches, or other regions of local peculiarity leading to increased local stress. If these regions of stress concentration are small, the stress will depend upon the irregularities of atomic motion in the neighbourhood—the so-called temperature fluctuations, which are the more violent the higher the temperature. Every now and then the atoms so will dispose themselves that, speaking loosely, the crack is sharper: the longer one waits the greater the chance that the local stress reaches some high critical value. This conception is due to Becker[9]: it has been elaborated by Orowan. The rate of flow of a crystal under stress will be proportional to the frequency with which the critical stress is reached. This leads to the following formula for the rate of glide, u:

$$u = Ce^{-V(R-qS)^2/2GkT},$$

where R is the true critical shear stress, S the average externally applied stress, q a factor to represent the increase at a "notch", G the shear modulus, k Boltzmann's constant, T the absolute temperature, and V a certain small volume.

This formula has certain interesting consequences. It shows the rate as depending very strongly on the stress: according to it, flow should take place at any stress, but if the stress is below a certain value the flow is unobservably small. This is the kind of thing we must expect to find in theories based upon probabilities.

If this view is correct, we cannot define a critical shear stress for a single crystal by saying it is the resolved shear stress at which glide begins to take place, for this will depend upon what rate we are prepared to consider noticeable. I have suggested that we define it as that at which an extension of 1 per cent per hour takes place. This seems a convenient arbitrary figure, but it is nothing more. The exact rate does not make much difference: in the case of very pure cadmium, considered by Roscoe and myself[10], stresses of 1·5, 1·3 and 1·0 bar gave rates of 1 per cent per 13 minutes, per hour, and per 7 hours respectively.

This way of regarding critical shear stress as the stress at which a determined slow rate of glide begins also explains a remarkable fact, as pointed out by Orowan, who has emphasized the importance of concentrating on the rate of flow as a property of the single crystal. While the rate of flow at a given stress increases very rapidly with the temperature, at a given stage of the flow, and the strain hardening is also very susceptible to temperature, the critical shear stress is not very much influenced by temperature: even at $-235°$C. it is, for cadmium, only four times as big as it is a few degrees below the melting-point of the metal. If we take the critical shear stress to correspond to a fixed value of u at all temperatures, this means that $(R - qS)^2/T$ is approximately constant, which gives $S = A - B\sqrt{T}$, a relation which agrees quite well with experiment.

The difficulty of interpreting curves showing the shear stress plotted against extension ('hardening' curves) will now be clear. If flow is taking place all the time, these curves will depend upon the rate at which stress is increased. By working within a region where the rate of flow is very small, and applying the stress fairly rapidly, hardening curves with some meaning can be obtained, but sufficient attention has not always been given to this point. The whole question is a troublesome one, complicated by the effect of recovery, that is, a crystal that has been hardened by strain becomes soft again if left to itself at a sufficiently high temperature: for 'soft' metals, like cadmium, room temperature is sufficient. Actually, true flow in the absence of recovery undoubtedly exists, as can be demonstrated by working at low temperatures, where the rate of recovery must be so exceedingly slow as to be quite negligible: but recovery undoubtedly plays a part in flow at higher temperatures.

The time element being eliminated as best one can, curves showing the variation of stress with glide at temperatures suitably chosen can be obtained. Some very striking results are available on metals of comparatively high melting-point. Measurements made by Sachs and Weerts[11] and by Osswald[12] show that with a single crystal of nickel a shear strain of 30 per cent produces an increase of shear strength of fourteen times; with copper a shear strain of 67 per cent produces an increase of strength of sixty-eight times; while with silver a shear strain of 95 per cent produces an increase of strength of ninety-two times, all at atmospheric temperature. In many cases the hardening at low temperatures varies as the square

root of the glide: at high temperatures it tends to show a linear variation.

We have now to consider how this hardening under strain comes about, and here X-rays furnish a valuable method of attack.

If we take a Laue photograph with an unstrained single crystal, we obtain a pattern of single spots, of the familiar type, but if we strain the crystal the spots are drawn out into smears, called 'asterisms', just as would be observed in the case of a large number of crystals, oriented in slightly different ways, so as to give a train of overlapping spots. The heavy strain has produced a change in the crystal structure; in fact it looks as if the single crystal is strong because it is no longer a single crystal.

With Miss Chow I carried out some experiments[13] on sodium single crystals, extending them by an equal amount at various temperatures and measuring (1) the stress required to produce this extension, (2) the spread of the asterism. It is easy to measure this with sodium, since the asterism takes the form of discrete spots, due, as we showed, to recrystallization; the separation of the extreme spots represents the range of rotation of crystalline fragments produced by stress. These experiments show that at low temperatures, where the crystal is strong, the spread is much greater than at higher temperatures, where it is weak, for the same overall strain. We have also been able to establish some numerical regularities. I think, then, that there is now definite evidence that the strengthening is largely due, at any rate, to the break-up of the crystal, to a loss of its single crystal character. Much more experiment is, however, needed to clear up the situation.

Polycrystalline Metals

This brings us half-way to real metals and the problem which interests the engineer—Why are polycrystalline metals strong? There are very few experiments available on the dependence of strength on grain-size. In its simplest aspect this problem demands an absence of plastic deformation, which at once complicates the question, but on the whole it looks as if small grain size is favourable for strength. During plastic deformation slip takes place in the individual crystallites, the axes of which are differently oriented. In some way the boundaries between the crystallites must confer strength, but they cannot do it because they are inherently strong—the number of atoms involved is too small. Expressed in another way, the crystal boundaries cannot be regarded as playing the part of the steel rods or expanded metal in reinforced concrete: they are too thin, whatever reasonable strength be attributed to them.

Supposing that, to account for their weakness (low yield-point) as compared with ideal crystals, we accept the hypothesis that the crystallites contain submicroscopic flaws, similar to Griffiths cracks in glass, where the stress-concentration is abnormally high. If a dislocation runs from such a crack it will travel as far as a crystal boundary and will then find, for a region a few atoms thick, in any event, a place where the regularity necessary for it to propagate itself is lacking—it loses itself, but not because the boundary is hard, rather because it is soft. An experiment which I carried out some time ago may illustrate the point.

To show the effect of crevasses in weakening a solid, I cut transverse slots in celluloid strips, and compared the strength of these strips with that of other unpierced strips, of equal carrying breadth. The weakening effect of the cuts which was to be anticipated did not, however, show itself. Examination shows that at the ends of the crevasse, where the curvature was greatest and tearing should have taken place, the celluloid had yielded plastically, with slight local deformation made evident by a turbid appearance. The theoretical weakening effect of a crevasse is based upon a postulated rigid behaviour of the solid: if the solid yields plastically the local stress is dissipated and the tearing does not take place. The analogy is not a perfect one, but it does show how strengthening can take place by weakness.

There is no doubt that the intercrystalline boundaries play a very important part in the strength of metals. However, the experimental study of the properties of these boundaries is only just beginning, and, although Chalmers[14] has carried out interesting experiments on the subject, much work with different metals and at different temperatures is required before we have enough material to found a comprehensive theory. The properties of single crystals of metals may seem curious and curiously remote from anything that the engineer experiences, but it is in terms of their behaviour, and of the behaviour of the less regularly ordered atoms in the boundaries between crystals, that we must seek an explanation of the secrets of the ironmaster and of the worker in non-ferrous metals.

1 *Z. Phys.*, **41**, 907 (1927).
2 *Phil. Trans. Roy. Soc.*, A, **221** 163 (1921).
3 *Proc. Roy. Soc.*, A, **159**, 346 (1937).
4 *Phil. Trans. Roy. Soc.*, A, **235** (1935).
5 Unpublished.
6 *Z. Phys.*, **82**, 235 (1933).
7 See, for example, C. F. Elam, "Distortion of Metal Crystals", Oxford, 1935.
8 *Proc. Roy. Soc.*, A, **145**, 362 (1934).
9 *Phys. Z.*, **26**, 919 (1925).
10 *Proc. Phys. Soc.*, **49**, 152 (1937).
11 *Z. Phys.*, **62**, 473 (1930).
12 *Z. Phys.*, **83**, 55 (1933).
13 *Proc. Roy. Soc.*, A, **175**, 290 (1940).
14 *Proc. Roy. Soc.*, A, **175**, 100 (1940).

OBITUARIES

Dr. John Ball

BY the death of Dr. John Ball, science has lost a man of outstanding character and calibre, whose experience and contributions ranged over a wide field. His career was marked by hard work, enthusiasm, an inquiring and penetrating mind, a perception of essentials, with bold ideas and restless vigour. John Ball loved a problem and was relentless in pursuing it. New evidence and new methods usually intrigued him, though at times he seemed obdurate before accepting them. Many who read this obituary will remember with affection the breathless discussions in Egypt, London, and elsewhere, in which his partial deafness was overcome by cheerful enthusiasm, his electric device, and the seemingly endless supply of new batteries. He loved a meeting of those who shared common interests, such as the Zerzura Club of desert travellers, and the conversation on these occasions remained practical, technical, constructive; there was always something worth learning. He served in Egypt for forty-four years, and remained there during the present War; to this fact possibly his recent death in his seventieth year may be attributed.

The following is a brief sketch of Ball's career. He was educated at the Royal College of Science and Royal School of Mines, Freiberg, and the University of Zurich, and apprenticed to the Phœnix Foundry Co., Derby, where he was engaged on some important engineering works, including the Battersea Bridge, and the Liverpool Overhead Railway. The Royal School of Mines recognized his merit: then his career took him into mining, and he spent a year or so in Germany and Spain. From this period of his life four sciences already seemed to stand out, namely, mathematics, engineering, surveying, and geology. He was a marked man for the type of reconstruction and development which was afoot in Egypt at the end of the last century, and joined the Survey of Egypt in 1897. The second period of his career, which had a logical development over nearly half a century, showed the same basic interests. He was responsible for under-pinning the Temples at Philae during 1901–2 when the Assuan Dam was constructed. There was a primary demand for his geology and surveying, which bore fruit not only in his classical work on the geology of the First Cataract, but also in the early surveys of the Libyan oases of Kharga, Baharia, Kurkur, and of the south-eastern deserts of Egypt.

Geology and topographical survey developed Ball's interest in wider exploration, and the War of 1914–18 provided unexpected opportunities. John Ball and other officials and officers ranged far beyond the Egyptian oases of the Libyan Desert with the military motor patrols, and over Sinai; useful series of maps were produced for military purposes. He conducted surveys for the British Government in Somaliland and Arabia, and collaborated with the R.A.F. in the surveying of the Cairo-Baghdad air route in 1921.

Among all these efforts, the Libyan Desert seems to have intrigued Ball more than any, and it is in a sense true to say that much of his interest in the period from 1919 was devoted to that empty quarter. Thus he accompanied Prince Kemal ed Din on three of his expeditions, including the momentous journey to Merga and 'Uweinat. Many problems set his logical brain at work; for example, the nature and origin of the artesian water supplies in the oases, the growth and movement of the great sand dunes, and later the Qattara Depression near the Mediterranean coast, considered as a potential source of hydro-electric power. The examination of these problems of the Libyan Desert, which could not be the work of one man, was shared first by the small band of Survey officers past and present, secondly by a growing number of travellers who were not officials of the Egyptian Service. Discoveries and routine work of all of them were grist to the mill. Cars replaced camels, the sun compass, of which Ball was a pioneer, superseded native guides. His contributions included his early use, if not the first, of the depression angle method of coastal surveying, and his "Handbook of the Prismatic Astrolabe".

For many years after 1918, Ball was Director of Desert Surveys in Egypt, and then Technical Counsellor until his death. In his later years none of his interests seemed to flag. His last considerable work was his "Contributions to the Geography of Egypt" (1939)—in effect a series of essays on problems that had long claimed his attention, especially the development and history of the Nile and of its perplexing and troublesome appendix the Faiyum. In these essays all the initiative, perception and youthful enthusiasm remained, and if others may not agree with all his conclusions, nevertheless his evidence and deductions are clear for all to read.

John Ball received many honours, and perhaps those which he valued most were the De la Beche Medal of the Royal School of Mines, his D.Sc. of the University of London, the Mejidie (for his work at Philae), and the Victoria Medal of the Royal Geographical Society (primarily for his pioneer scientific work in the Libyan Desert). His wife and son survive him.

K. S. SANDFORD.

WE regret to announce the following deaths:

Prof. M. Bodansky, professor of pathological chemistry in the Texas University School of Medicine, aged forty-five.

Mr. W. H. Heaton, formerly principal of University College, Nottingham, aged eighty-five.

Prof. F. Kafka, director of the Psychiatric Clinic in the German University of Prague.

Prof. H. Klein, professor of neurology and psychiatry in the University of Leipzig, aged sixty-six.

Prof. A. Westphal, professor of neurology and psychiatry in the University of Bonn.

NEWS AND VIEWS

Book Production in War-time

After lengthy discussions last year, books were exempted from the Purchase Tax, on the grounds of their cultural value and their value as exports. Having survived the threat of ordeal by taxation, books are now confronted by the ordeal of war-time shortage of materials and labour. Lord Samuel raised the question of book supplies in the House of Lords on October 23. Apart from the fact that book production in Great Britain last year amounted to £10,000,000, of which a third was for export, he pointed out that only a fraction was what may be termed 'light literature'. Books are urgently needed in the Services, by munition workers, technicians, scientific workers and medical students. No fewer than twenty million volumes have been destroyed by enemy action. Publishers are already working with about 50 per cent of their pre-war supplies of materials; further withdrawal of materials and labour would be a serious blow to the national interest.

Lord Snell replied on behalf of the Government. He said that the Government is not indifferent to the issues raised. The real difficulty has arisen from the shortage of material for making paper. Since 1940 we have lacked supplies from Scandinavia and Finland, and have had to depend on North America. He asserted that the Ministry of Labour has reported that there is no serious shortage of labour for the production of books, and the Board of Education has had no representations of a serious shortage of books for elementary or secondary schools. He thinks something might be done to economize by using thinner paper, narrower margins and the collection of waste paper.

The significance of this reply turns on the interpretation to be placed on the words "serious shortage". Shortage there is bound to be in these days of stress and trial, even apart from the need for replacing at least some of the twenty million volumes destroyed. Nevertheless, the fact remains that many standard text-books have been unobtainable in recent months. In many cases the books are already printed and are awaiting binding. Few new books of this character are being published. Shortage of paper has little to do with this situation, as a consequence of which students of all types are deprived of essential books. As regards the suggested economies, it has to be remembered that many text-books are printed from electrotype plates. Thus the size of the page is fixed when the book is first made, and cannot be varied except within narrow limits. The low price of text-books, which are costly to produce, depends on the possibility of using such methods of production. It would seem therefore that every endeavour should be made to see that further restrictions are not imposed. Lord Samuel has done well to direct attention to the dangers of the situation.

Use of Paint in Camouflage

Sir John Graham Kerr, a member for the Scottish Universities, spoke in the House of Commons on October 23 on the use which is being made of camouflage. He divided camouflage roughly into two aspects, structural, and by pigment and paint respectively. Structural camouflage, whereby an attempt is made to disguise or even to hide a building or object, is, in Sir John's opinion, reasonably well done. Where the use of paint is concerned, as in concealing or giving a misleading appearance to an object such as a gun, he contends that present practice is ineffective. The general principles of camouflage by paint are well established, based on observations on wild animals: they are counter-shading and dazzle. Counter-shading, in which an animal is dark above and light underneath, the two regions merging into one another, reduces the appearance of relief and makes an animal appear flat. Dazzle has for its function the breaking-up of the surface and outline by violently contrasting tones of pigment. Both methods are observed operating effectively in wild animals. They have been elucidated, and also applied to warfare, by biologists. Yet the illustrations in current periodicals, and also direct observation, show that guns, vehicles, etc., are not being properly camouflaged. Sir John also referred to a recent picture of the Prime Minister against a background of guns which are "coloured, dark above and white below . . . [the colours] separated by a sharp line which does away with nine-tenths of the effectiveness that the counter-shading should have". The fundamental principles of camouflage being known, steps should be taken to apply them correctly, in order to obtain the maximum protection.

President Roosevelt on Resource and Research

In the *Bell Laboratories Record* of July is printed a report on "Research—A National Resource. Part II, Industrial Research" which was transmitted to the Congress of the United States by President Roosevelt. The report was prepared by the National Research Council, of which F. W. Willard, president of the Nassau Smelting and Refining Company, was chairman. Among members of the committee were F. B. Jewett, O. E. Buckley and R. R. Williams. The chapter on mathematics in industrial research was written by T. C. Fry. The President included with the Report the following message.

"To the Congress of the United States:

"One of the greatest resources in the arsenal of democracy is our national ability and interest in Industrial Research. For the vigorous prosecution of our defense program and for the assurance of national progress after the emergency we rely heavily

on the continued vitality of research by industry in both pure and applied science.

"Our people can justly take pride in the record of the accomplishment by American industry contained in the report on 'Research—A National Resource. Part II, Industrial Research' which I am transmitting for the information of the Congress . . . .

"The report presents a clear record of how successfully we have translated our old time Yankee ingenuity for invention into American genius for research. Our scientists have uncovered and explained the secrets of nature, applied them to industry, and thus raised our standard of living, strengthened our defense and enriched our national life. . . . I commend a careful reading of this report to the members of the Congress.—Franklyn D. Roosevelt."

Development of the British Broadcasting Service

THE president of the Institution of Electrical Engineers for the current session is Sir Noel Ashbridge, engineering controller of the British Broadcasting Corporation. In his inaugural address to the Institution given on October 23, Sir Noel reviewed the growth of broadcasting in and from Great Britain from the beginning of the public service in November 1922 up to the present time. Prior to the War, the home broadcasting service utilized transmitting stations operating on wave-lengths in the long and medium wave-bands, agreed upon at various international conferences, for the use of all European broadcasting stations. As these wave-bands would accommodate only 126 transmissions in separate channels, whereas the actual number of stations provided for was 340, it is obvious that a considerable amount of sharing of wave-lengths between two or more stations was involved. As a result of the constant attention, research and development devoted to the subject by engineers and scientific workers, it is estimated that in 1939 the B.B.C. had achieved the position whereby nearly 90 per cent of the public could obtain good reception of two programmes, and something more than 98 per cent one programme. One of the graphs illustrating the address shows that the number of British wireless licences has increased at an almost uniform rate of half a million a year from 1922 until 1939, when some nine million listeners were licensed.

An experimental broadcasting service on short wave-lengths to countries overseas was started in 1927, and continuous development and extension has taken place since then, particularly in the period 1936–39. The value of short-wave broadcasting for the rapid distribution of news, information and propaganda has been rapidly appreciated by all the belligerent countries, and it is of interest to mention that, at the present time, broadcasts in some forty different languages are radiated from Great Britain. In the field of television, Sir Noel reminded his audience that Great Britain was the first to inaugurate a regular service for reception by the public in their own homes. After two or three years of regular working, television in Great Britain is in the almost unique and advantageous position of having to make a new beginning after the War, when the settlement of some fundamental problems will affect the future of a new industry for many years to come. In the concluding section of his address, Sir Noel commented upon his experience in the recruitment of young engineers from the technical colleges and universities. He expressed the opinion that there is room for improvement in the amount of business and administrative instruction given to technical students, and also in the closeness of collaboration between teaching and industry. Several times during the address, reference was made to the difficulties which have arisen in the past concerning the international aspects of broadcasting. It is to be hoped that, after the War, a sound wave-length plan for Europe and possibly beyond, can be built up on rational principles with due regard for technical facts, and free from much of the politics which have coloured so many of the conferences in the past.

The Place of Paracelsus in Medicine

IN a paper on Paracelsus read before the Section of the History of Medicine of the Royal Society of Medicine on October 1, Dr. H. P. Bayon said that it had often been noted that Paracelsus expressed his intense scorn for all orthodox medical learning and tradition, but little had been said about his medical practice, which was that usual in his time (see also NATURE of September 20, p. 332). So far as medicine was concerned, Paracelsus was mainly a destructive fault-finder, not a constructive critic like William Harvey; moreover, much of what he propounded did not stand the test of time. Though he paid lip-service to experience rather than authority, he indulged in profuse theorizing without suitable clinical, anatomical or biological observation. His religious views helped to mould many of his doctrines, and his combination of Christian religious thought, neo-Platonic philosophy and alchemical medicine inspired the formulation of Rosicrucianism. This romantic system caused a great stir in intellectual circles in the seventeenth to the eighteenth centuries, so that the question whether Paracelsus reformed medicine is best answered by deciding whether Rosicrucianism had any part in the evolution of modern medicine, which can claim to have relieved pain, explained and conquered many infectious diseases and also to have prolonged life. Such achievements were the life-aim of Paracelsus, who had a high and noble conception of the possibilities of medicine, but failed in demonstrating how such progress could be obtained. A careful study of Hippocratic and Galenical writings would have taught him that clinical observation, prognosis and diagnosis, together with experimental therapy, would trace the path along which medicine and natural science could and did eventually advance.

The Bronze Age in Kent

AN interesting find of Bronze Age material near Canterbury has recently been announced. It appears that a mechanical excavator working at a brick-field brought to light three spearheads, several celts both socketed and winged, part of a knife and fragments of a shallow cauldron together with an ingot of

smelted bronze. Here, no doubt, we have the stock-in-trade of some travelling Bronze Age tinker collecting scrap and perhaps casting new types of tools—new lamps for old! Naturally, the date when the hoard was collected or abandoned cannot have been earlier than that of the most recent tools it contains, and these would suggest that the tinker plied his trade in the Late Bronze Age.

Such 'hoards' have been found before in Kent. The largest and most important is the so-called Minster hoard of no fewer than 143 objects, which included socketed and winged celts, swords, spear-heads, palstaves, a sickle, a knife, scrap metal, etc. Other well-known ones have been discovered at Allhallows, Broadness, Cliffe, Morden, Saltwood, Sittingbourne, Stoke, Swalecliffe and the Isle of Harty. Kent was an important part of the country in the Late Bronze Age, suffering as it then did from continental invasions which must have made life somewhat unsettled. Perhaps this is why comparatively little domestic pottery of the period has turned up. On the other hand foreign contacts did lead to an enrichment of the material culture of the district. It is perhaps noteworthy that the dead were disposed of by cremation, the ashes being placed in pottery urns which were deposited in pits dug in the ground and covered over by round tumuli.

Luminous Strontium Sulphide

The usefulness of most forms of phosphorescent paint is limited by the rapid decay in luminosity when exposed in the dark. A new preparation with an appreciably longer useful luminous glow has recently been marketed; the phosphorescent material is luminous strontium sulphide, which is applied over an undercoat of titanium oxide. The makers are British Luminous Industries, Ltd., London, N.W.10. Apart from the many obvious uses in the 'black-out' (signs and markings would be quite invisible at any distances to which aircraft might approach), it is suggested that the application of this material to the ceilings of shelters and public buildings would provide illumination in the event of the failure of the normal lighting. The luminosity immediately after activation is so strong that this suggestion seems practicable.

Theodor Ritter von Oppolzer (1841–1886)

On October 26 occurred the centenary of the birth of the Austrian astronomer Theodor Ritter von Oppolzer who from 1876 until his death on December 26, 1886, held the chair of astronomy at Vienna. Born at Prague, he was the only son of Johann von Oppolzer, (1808–71), a well-known pathologist who held chairs first in Prague, then in Leipzig and Vienna. Though he took a degree in medicine, Theodor von Oppolzer, being of independent means, devoted his time to astronomy and built a private observatory. For ten years he studied asteroids and comets, on which he published a well-known "Lehrbuch". In 1873 he became connected with the great European degree measurement, and for some years was chairman of the Austrian Commission. In his later years he studied planetary disturbances, the motion of the moon, refraction and other subjects. His most notable contribution to science, however, was his "Canon der Finsternisse", containing the elements of eclipses of the sun and moon, some 13,000 in number, from 1207 B.C. to A.D. 2162 (1887). Among the honours he received were his election as an associate of the Royal Astronomical Society and as a corresponding member of the Paris Academy of Sciences. His son Egon (1869–1907) was an assistant at Prague Observatory and professor extraordinary at Innsbruck.

Ages of American Men of Science

In view of the comments on the present-day status of youth in science, beginning on p. 511 of this issue, the analysis of the ages of men of science on the U.S. National Roster of Scientific and Specialized Personnel presented by Dr. L. Carmichael, president of Tufts College and director of the Roster, to the American Psychological Association is of interest. More than one fourth of the first sixty thousand men of science listed on the Roster are less than thirty years of age. More than half are less than forty. Only a fifth are more than fifty. The total on the Roster now is more than 180,000. The Roster is the reservoir of scientific and other personnel in the United States for the defence programme, and is similar to the Central Register of Great Britain.

Recent Earthquakes

The U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the tentative epicentres of four recent earthquakes from reports received from seismograph stations. On August 2 the earthquake at 11h. 41·5m. U.T. had its epicentre near latitude 30° S., longitude 178·5° W. This is in the Pacific Ocean just west of the Kermadec Islands and the Aldrich Deep so that the suggested depth of focus of 100 km. is not unusual. Deep-focus earthquakes are frequent in this area. The earthquake of August 4 at 10h. 53m. U.T. probably had its epicentre near latitude 52° N., longitude 176·5° W., which is in the north Pacific Ocean near Adak Island of the Aleutian Islands group. The depth of focus of 100 km. was somewhat unusual for the district though it was exceeded by as much as 100 km. by the earthquake of August 6 at 6h. 15·3m. U.T. The epicentre of this latter shock was on the Alaska Peninsula. On August 15 the earthquake at 6h. 9·5m. U.T. probably had its epicentre near latitude 19° N., longitude 27° W., which is in the Atlantic Ocean north-west of St. Vincent of the Cape Verde Islands. As all these shocks had epicentres distant from human habitation no damage has been reported, but had they been near centres of population they would undoubtedly have been strong enough to cause considerable damage.

During the first fortnight of September, eight large distant earthquakes were registered at Kew Observatory. All gave a full suite of pulses, the greatest being on September 9. This started recording with a probable *iPKP* wave (compressional) at 7h. 38m. 52s. U.T. from a calculated epicentre distant

14,650 km. It reached its maximum at 8h. 30m. 4s. U.T. with a wave of period 28s. and ground amplitude of 66 μ at Kew. The shock of September 4 was only a little less intense and was probably better recorded. It commenced with *ePz* at 10h. 37m. 54s. U.T. from 15,300 km., attained a maximum of 56 μ at 11h. 30m. 34s. U.T. and finished recording at 14h. 10m. Two shocks were recorded on September 14, the first at 4h. 28m. 30s. U.T. from 12,600 km. and the other at 13h. 48m. 43s. U.T. probably from the same epicentre. All identifications and calculations are tentative.

During the latter half of September 1941, four large distant earthquakes were registered by the seismographs at Kew Observatory. The first, on September 16, began recording at 21h. 59m. 1s. U.T. with a probable $iPKP_1$ compressional wave on the vertical record, and from the tentative interpretation of the record it may have come from an epicentre 17,800 km. distant from Kew. The maximum ground movement attained an amplitude of 70 μ. The shock of September 18 began recording at 2h. 24m. 46s. U.T.; but since the pulses were small and emergent no interpretation can be given with confidence. The earthquake of September 21 began recording with *ePz* at 22h. 45m. 44s. U.T.; had a possible *S* at 50m. 12s., *eLQ* at 55·5m. and eL_R at 54·5m. The shock of September 24 was greater than the two previous ones. With a possible *iSKS* at 1h. 13m. 11s. U.T., it came from a probable epicentral distance of 11,850 km. and attained a maximum ground amplitude at Kew of 27 μ at 1h. 56m. 6s. U.T.

The Night Sky in November

THE moon is full on November 4 at 2h. U.T. and new on November 19 at 0h. 4m. Lunar conjunctions with the planets occur on the following dates: Mars on November 1d. 15h., Mars 0·1° S.; Saturn on November 5d. 7h., Saturn 2° N.; Jupiter on November 7d. 8h., Jupiter 4° N.; Mercury on November 17d. 17h., Mercury 2° S.; Venus on November 22d. 10h., Venus 8° S.; Mars on November 28d. 22h., Mars 2° N. On November 17 Saturn is in opposition to the sun and on November 21 Uranus is in opposition to the sun. The distances of the planets from the earth are then 756 and 1,719 million miles respectively. Mercury, Jupiter and Neptune are morning stars; Saturn is a morning star until November 17, and after that an evening star. Uranus is a morning star until November 20 and then it becomes an evening star. Venus and Mars are evening stars. Mars is a conspicuous object, crossing the meridian at 22h. 6m. and 20h. 13m., at the beginning and end of the month, respectively. Two meteor showers occur during the month. The Leonids, associated with Tempel's Comet, are visible on November 13–14, the radiant point being about R.A. 10h., Dec. + 22°. The Andromedes, associated with Biela's Comet, can be seen during November 18–24; the radiant being at R.A. 1h. 40m., Dec. + 43°. The Leonids are visible in the morning hours and the Andromedes can be seen in the evening. The Andromedes paths can easily be traced as they are slow moving meteors.

Comet van Gent (1941 *d*)

IN NATURE of August 2, p. 139, it is stated that a new comet (1941 *d*) had been discovered by Dr. H. van Gent, of Bosscha Observatory, Lembang. Dr. van Gent, writing from the Union Observatory, Johannesburg, informs us that the comet was discovered by him from plates taken with the Franklin Adams telescope at that Observatory. The comet was also discovered, independently, by Mr. G. du Soleil, Observatoire Privé, Kilominos (Ituri), Belgian Congo, on July 12.

Announcements

AT the quarterly meeting of the council of the Royal College of Surgeons of England it was announced that Mr. D. L. Kerr has been admitted as a Macloghlin scholar, and that Prof. John Beattie has been appointed Bernhard Baron research professor. The following awards were reported: a Prophit studentship to Dr. J. Clark Davidson; a Mackenzie Mackinnon research fellowship to Dr. Geoffrey Bourne.

AT the annual meeting of the Royal Society of Edinburgh held on October 27, the following officers were elected: *President*, Prof. E. T. Whittaker; *Vice-Presidents*, Dr. Leonard Dobbin, Prof. R. Stockman, Prof. James Ritchie, Dr. G. W. Tyrrell, Prof. C. T. R. Wilson and Dr. James Watt; *General Secretary*, Prof. James P. Kendall; *Secretaries to the Ordinary Meetings*, Prof. R. J. D. Graham and Prof. W. M. H. Greaves; *Treasurer*, Dr. E. M. Wedderburn; *Curator of the Library and Museum*, Dr. J. E. Mackenzie; *Councillors*, Mr. A. Graham Donald, Dr. Alan W. Greenwood, Prof. T. H. Milroy, Dr. W. P. D. Wightman, Prof. Edward Hindle, Prof. J. R. Matthews, Sir Arthur Olver, Dr. David Russell, Dr. Robert Campbell, The Right Hon. Lord Cooper, Prof. E. W. H. Cruickshank and Sir J. Donald Pollock, Bart.

THE Royal College of Surgeons of England has announced a vacancy for a Prophit studentship in cancer research. The studentship will not exceed the annual value of £500 with an allowance not exceeding £200 for expenses of travelling, and will be for one year in the first instance, but is renewable. Further information can be obtained from the Secretary, Royal College of Surgeons, Lincoln's Inn Fields, W.C.2. Applications should be made before November 22.

ERRATUM.—Sir Arthur Hill writes: "In my article 'The Search for Economic Plants, in NATURE of July 5, p. 15 and July 12, p. 42, Ephedra was accidentally included among the plants yielding important insecticides (p. 44, line 5 from base). This is, of course, incorrect. The alkaloid ephedrine, which is derived from the dried twigs of two Chinese and an Indian species of Ephedra (Gnetaceæ), is similar in its physiological effects to adrenaline in moderate doses. Ephedra plants and seeds have been sent by Kew to suitable Colonies in the hope of producing a supply of this valuable drug."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Action of Fast Hydrogen Ions on Lithium Chloride

We have bombarded targets of various light elements in the course of experiments on nuclear resonances ($p - \gamma$ reaction), and have noticed an interesting phenomenon with lithium chloride targets.

These targets were prepared by fusion of the hydrated salt (m.p. 490–600° C.) on to molybdenum surfaces. During bombardment with hydrogen ions ($^1H^+$ and $^2H^+$ in roughly equal proportions) at current strengths up to 100 microamp. and voltages up to 600 kv., the white colour of the targets changed to purple in the regions struck by the beam. The intensity of coloration increased with increasing current density, and in the centre of the bombarded region the target was black. The effect was confined to the surface as the coloured part could be scraped off the target. On exposure to the atmosphere the colour reverted gradually to white in about 3–5 minutes.

We considered that the phenomenon was possibly due to the formation of finely divided lithium, by reduction of the chloride, which would presumably be changed to the hydroxide on continued exposure to moist air. The appearance of blue rock salt, stated by some authorities to be due to the presence of colloidal sodium, seemed to support this view. Mellor's chemical treatise[1] refers to this matter with reference particularly to cathode ray bombardment[2], and mentions also the alkaline subchlorides, for example Li_2Cl, some of which are coloured, although their composition seems uncertain. The protonic range in the target was probably less than 6×10^{-4} cm., so diffusion of air into the target might be expected to be rapid in the region occupied by products resulting from the action of the beam. The possibility of some chemical reaction with the molybdenum backing plate was unlikely. The purple coloration was not found with lithium hydroxide or oxide targets, the former turning grey on bombardment.

These experiments suggest that the purple coloration was due to the formation of a subchloride. Experiments with another halide, calcium fluoride, also led to the production of purple targets on bombardment. In this case, the colour persisted for four days, after which the target was destroyed. The effect of oil vapour from the pumps used to evacuate the acceleration tube may be ignored. It was suggested to us that the effect was due, not to the primary positive ion beam, but to secondary electrons arising at the target. This is considered an improbable process, as the energy of most of these electrons would only be ~ 100 ev. Also, the fact that the coloured areas were fairly sharply defined, and limited to the part of the target struck by the primary beam, suggests that the secondary electrons were not responsible for the effect.

In view of the fact that there is no immediate prospect of continuing the experiments, it seemed that publication of a note, even at this stage of the work, would be of interest.

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[1] Mellor, "A Comprehensive Treatise on Inorganic and Theoretical Chemistry".

[2] Thomson, "Conduction of Electricity through Gases", 2, 4 (1933).

Penetrating Non-Ionizing Cosmic-Ray Particles

The main part of the non-ionizing component of cosmic radiation near sea-level consists of photons[1] and neutrons[2]. A rough survey carried out by Rossi and his co-workers[3] at sea-level did not give any evidence of penetrating neutral particles. Experiments of the same type by Rossi and Regener[4] at 4,300 m. above sea-level, however, show the existence of a small number of penetrating neutral particles. We have carried out similar experiments at sea-level with positive results.

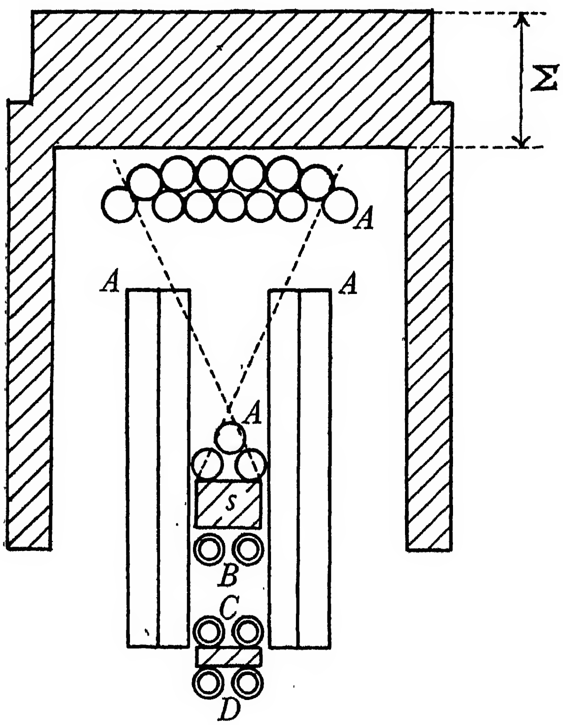
The experimental arrangement is reproduced schematically in the accompanying illustration. The threefold coincidence set *BCD* and the absorber *s* are surrounded on all sides except the bottom by an anticoincidence system *A* consisting of 76 counters in parallel. To avoid anticoincidences due to photons, the arrangement is surrounded by 5 cm. of lead. Some of our observations are given in the table below.

Σ	*BCD-A* (corrected for random coincidences *BCD, A*)		*BCD*	
Lead (cm.)	Time (hr.)	Rate (c./hr.)	Time (min.)	Rate (c./min.)
5·0	469·1	0·533±0·039	251	11·86±0·22
12·5	445·8	0·451±0·036	250	11·03±0·21
25·0	407·7	0·283±0·030	313	10·27±0·18
5·0+30·0 cm. Al	427·3	0·362±0·034	323	10·72±0·18

An anticoincidence *BCD-A* may be due to any one of the following effects: (1) A non-ionizing agent emerging from Σ, which produces an ionizing secondary in *s*; (2) a particle which travels upwards, gives rise to coincidence *BCD*, and is afterwards stopped in *s*; (3) an ionizing particle which leaks through *A*. The rate of anticoincidences due to (2) is not affected by Σ, while that due to (3) is no

more affected than the threefold rate *BCD* itself. Thus the decrease of the anticoincidences rate due to (3) when Σ is increased from 5 cm. to 25 cm. of lead is estimated to be rather less than 0·04 c. per hour. The difference of $0 \cdot 25 \pm 0 \cdot 05$ anticoincidences per hour observed between the rate with $\Sigma = 5$ cm. lead and the rate with $\Sigma = 25$ cm. lead must therefore be mainly due to non-ionizing particles.

If the anticoincidences with $\Sigma = 25$ cm. lead are taken as background, then the mean free-path of the neutral particles is about 10 cm. of lead, while the intensity of the neutral beam is estimated to be 0·03 per cent of the total cosmic ray beam at sea-level.



Anti-coincidence counter (A) ○ ◎ Coincidence counter

Comparing our data with those of Rossi and Regener, we estimate that the neutral intensity at Mt. Evans is 30–60 times greater than at sea-level. This increase, if exponential, corresponds to a mean free-path of the neutral particles of about 100 gm. per cm.^{2}, in good agreement with the observed absorption in lead.

In order to give a possible interpretation of the observations, we consider the following processes. A fast neutron suffering a head-on collision with a proton inside a nucleus can transfer almost its whole momentum to the proton. According to Heisenberg[5], the mean free-path of a neutron which is stopped according to such a process is 12·5 cm. of lead. This process alone does not account for our observations, since the reverse process of protons producing neutrons should make the neutrons reappear. It has been suggested by Jánossy[6], however, from observations on penetrating showers, that fast protons traversing matter are quickly stopped by interaction with nuclear Coulomb fields, giving rise to penetrating showers. These two processes together would give for the mean free-path of the neutral radiation a value of about 140 gm. per cm.^{2}, in agreement with the present observations.

Further, it can be shown that the above interpretation of the observations accounts at the same time for the fact that the rate of particles producing penetrating showers[6] (0·01 per cent) and the rate of neutral particles are of the same order of magnitude.

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[1] Jánossy, L., and Rossi, B., *Proc. Roy. Soc.*, A, 175, 88 (1940).
[2] A summary of this work will be found in a paper by Bethe, H. A., Korff, S. A., and Placzek, G., *Phys. Rev.*, 57, 573 (1940).
[3] Rossi, B., Jánossy, L., Rochester, G. D., and Bound, M., *Phys. Rev.*, 58, 761 (1940).
[4] Rossi, B., and Regener, V. H., *Phys. Rev.*, 58, 837 (1940).
[5] Heisenberg, W., *Leip. Akad. Wiss.*, 89, 369 (1937); *Naturwiss.*, 25, 749 (1937).
[6] Jánossy, L., *Proc. Roy. Soc.*, A, in the press.

Afterglow in Mercury Vapour

IN recent papers on this subject, Moore and Garth[1] describe experiments which indicate that the phenomenon is due to the existence of excited atoms which are formed, after the excitation has been cut off, by the dissociation of molecular particles. They suggest that this particle is the 'excited' molecule proposed by Arnot and Milligan[2].

Later experiments by Arnot and M'Ewen[3] have shown that the mercury molecular ions are formed by the three processes:

$$(1)\quad \underset{4\cdot86\text{ ev.}}{Hg'(2\,{}^3P_1)} + \underset{4\cdot66\text{ ev.}}{Hg'(2\,{}^3P_0)} \rightarrow Hg_2^+ + \varepsilon;$$

$$(2)\quad \underset{9\cdot72\text{ ev.}}{Hg'(4\,{}^1P_1)} + Hg \rightarrow Hg_2^+ + \varepsilon;$$

$$(3)\quad \underset{9\cdot82\text{ ev.}}{Hg'(5\,{}^3P)} + Hg \rightarrow Hg_2^+ + \varepsilon;$$

where Hg′ denotes an excited atom and ε a free electron. The energy associated with each state is given in electron-volts. Evidence was also obtained that excited atoms in states other than *P* states do not apparently form ionized molecules by attachment even when they have more than sufficient energy to do so.

It has occurred to me that this may be due to the existence of certain unstable or repulsive states of the mercury molecule. Such states will be associated with atoms in *S* or *D* states, while stable molecular states will be associated with excited atoms in *P* states.

In accordance with the generally accepted view that positive ions formed in the discharge are the source of the excitation in the afterglow, it now appears that in mercury vapour the phenomenon has its origin in the molecular rather than the atomic ion as previously supposed.

A molecular ion capturing an electron may fall into either a stable or an unstable state. The formation of stable excited molecules will lead to the band spectrum of the afterglow. On the other hand, if the above assumption is correct, electron capture may result in spontaneous dissociation of the ion into an excited atom, in an *S* or *D* state, and a normal atom. This process will be non-radiative since any excess

energy will be carried off by the products of dissociation. Consequently the line spectrum will show strong lines originating from atoms in S or D states, and these lines will be characterized by the absence of continua. Lines originating from atoms in P states will be relatively weak, since stable excited molecules may radiate and fall to the ground-state before dissociation takes place.

Moore and Garth have made a careful investigation of the relative intensities of the lines in the afterglow spectrum and note all these features. Their calculation of the rate of direct excitation into each atomic level shows that the number of excited atoms (formed directly by molecular dissociation) in the D, S and P states are approximately in the ratio 80 : 20 : 1. This is in good agreement with the suggestion given here.

The quenching produced by electrons having a few volts energy may be due to the dissociation of the molecular ion into an atomic ion and a normal atom, a process which requires an energy of 0·87 volts. The accompanying increase in the intensity of the resonance radiation is not so readily explained. This production of atoms in the 2 ^3P states may, however, account for the recovery of the glow beyond the quenched region, since fresh molecular ions may be formed in the streaming vapour by the process (1) given above.

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Oct. 11.

[1] Moore, G. E., and Garth, R. C., *Phys. Rev.*, 60, 208, 216 (1941).
[2] Arnot, F. L., and Milligan, J. C., *Proc. Roy. Soc.*, A, 153, 359 (1936).
[3] Arnot, F. L., and M'Ewen, M. B., *Proc. Roy. Soc.*, A, 165, 133 (1938).

The Relations between Science and Ethics

I AM sorry that Dr. Waddington (NATURE, Sept. 6) allows the word 'good' to be spelt with a capital, even if only once. The use of a capital letter makes an adjective appear to be a noun, that is, a thing, which has an independent existence, and this leads to endless confusion, such as that involving "Eternal Values", etc.

A more serious lapse (especially from one who has written on the scientific attitude) is the lack of definition of the terms used. Clear definition is essential to the progress of science, for the facts upon which its theories are built cannot be verified unless they are expressed in clearly defined terms which enable other research workers to establish similar conditions for observation or experiment. Now when we consider the subject of ethics we find at once that the words 'good' and 'evil' have never been clearly defined, and consequently the application of scientific method is impossible. Words are, of course, only symbols, and unless we know clearly how they are related to events in our actual lives, that is, their meaning, the use of them in sentences is mere word-spinning and leads only to confusion.

As regards the intimate connexion between science and ethics, I should like to repeat, in a more pertinent form, a point of view which I put forward in an essay-review of the Bishop of Birmingham's Gifford Lectures (*Science Progress*, **116**, 729; 1935):

(1) We strive for the greatest mental and bodily well-being, that is, happiness (fact of experience).

(2) This is greatest when others are also happy (fact of experience).

(3) To achieve (1) we should therefore strive for "the greatest happiness of the greatest number".

(4) To achieve (3) we require knowledge of facts about the actual world, and what would be the results, or probable results, of given actions in it.

(5) This knowledge is most reliably obtained by the exercise of scientific method.

(6) In order, therefore, to distinguish between good and bad conduct (good conduct being defined as that which conduces towards the greatest happiness of the greatest number and vice versa), we require knowledge obtained by science. Thus science is intimately connected with ethics.

Sections (1) to (6) might be said, I think, to form a basis for a scientific ethic. This is not a static conception, for with the continual increase in our knowledge, it might happen that an act formerly thought conducive to the greatest happiness of the greatest number would be found not to be so. This is an advantage in a world in which the only certain thing we can say about the future is that it will be different from the past.

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DR. WADDINGTON, as I understand him, has merely *defined* the good as that which tends to promote the ultimate course of evolution[1]. On what other basis can a man of science, or any adult for that matter, state that "the direction of evolution is good simply because it *is* good"? (The Dean of St. Paul's, in the same issue of NATURE, put his finger on this; what is defined cannot thereafter be deduced.) Dr. Waddington admits as much by his diffident, and somewhat belated, statement that his meaning of good is "not unrelated to the conventional meaning"[2]. One may well ask what all the fuss is about; a definition is beyond argument. Dr. Waddington is fully entitled to take a word in common use and define it, for his own purpose, as he pleases. Most sciences contain examples of such licence, and it can usually, although not always, be said that the definition "is not unrelated to the conventional meaning of the word". One only wonders, first, why Dr. Waddington required eight columns for his definition and, secondly, what it has to do with ethics.

Dr. Needham is on very different ground when he identifies the good as defined by Dr. Waddington with the already defined Christian attributes[3]. When he boldly claims that these latter are the bonds which most effectively organize a community at the level of humanity, he must be asked to produce his evidence. He may conceivably find difficulty in indicating a representative community which has so much as tried the recipe. We can, on the other hand, point to the most highly organized community of modern times, based on quite other principles and methods. On Dr. Waddington's perfectly consistent statement that the good is that which is effective, these methods are good; does Dr. Needham say they are also those enjoined by Christ?

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[1] NATURE, 148, 270 (1941).
[2] NATURE, 148, 342 (1941).
[3] NATURE, 148, 411 (1941).

DR. WADDINGTON appears to identify 'ethical' with whatever the super-ego demands, which is surely too sweeping. Even when it presents its demands in the name of conscience the super-ego is, emphatically, *not* always a trustworthy guide. Anyone who has studied the vagaries of conscience must agree that this still, small voice (or raging dictator) may, and sometimes does, inspire appalling behaviour; and conscience, as we recognize it, is only a small and relatively reasonable portion of the Freudian super-ego. Its less rational behests, in the form of morbid compulsions, may well land its victims in gaol, or in the mad-house.

Actually, diseased super-egos are the greatest menace with which humanity has to contend. According to Freudian psychopathology, intellectual and emotional abnormality results from the deadlocking of the vital human impulses by these misguided repressive super-egos. I therefore warmly agree with Prof. Julian Huxley about the close connexion between 'evil' and what he calls "the locking up of the 'energies' by the repressive mechanisms of the unconscious", and with his contention that 'good' may result from "releasing these 'energies' from their grapplings". It will only result, however, if some other type of control, better adapted to reality (that is, what Freudians call the 'ego') can be developed to take over the regulation of these energies, since blind decontrol would be no better than blind automatic repression. I am, however, entirely in agreement that the stultification of human 'energies' is 'evil' and their utilization 'good'.

The theory underlying this view of 'good' and 'evil', to which we both subscribe, seems to be that the subject-matter of ethics is human personalities; 'evil' would then roughly coincide with intellectual and emotional disease, 'good' with intellectual and emotional growth and sanity. This is, in fact, my own present working hypothesis with regard to ethics and I believe it is very like Dr. Waddington's. Human personalities seem to be important among the results which evolution has produced and so may be presumed to have been aimed at; moreover human personalities as they mature tend spontaneously to develop their capacities more fully and regulate their conduct more realistically. I suggest that we may apply the term 'good' to this developmental tendency, or rather to the personalities which, if it were successfully carried through, would be evolved by it.

Working against this tendency, however, there appears to be a counter-tendency, the results of which I suggest we should call 'evil', which arrests and even corrupts this developmental process. I do not know whether we are justified in excluding this counter-tendency from the scheme of evolution. The disquieting progress made by this 'evil' tendency *may* be due to the institutions of our particular 'culture' and thus may be remediable, provided human beings are not too corrupted already to be willing and able to undertake the task of altering their own unhealthy 'culture'. On this question we have not the knowledge, at present, to pass a final judgment, though, obviously, we must act as though they *were* capable of it.

A word in conclusion: with reference to Prof. Joad's question: "What . . . does all this talk about the super-ego and its imposition upon the personality . . . really amount to?", if Prof. Joad would study the curious phenomenon of compulsive behaviour, most clearly exemplified in obsessional neurotics, and would then familiarize himself with Freud's theory of intrapsychic conflict, he would get some inkling of the answer he is looking for. This study might, however, still take him some years, since it does not yet seem even to have begun.

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PROF. DINGLE[1] has picked out of my essay a sentence which, given the definitions with which I was operating, is a tautologous expansion of the argument. He appears to have thought that it was intended as an empirical statement, and he denies that it actually is empirical. From this basis he proceeds to reject my opposition to the apriorist view of ethics on the grounds that the opposition is itself apriorist, since it is not based on observation. He even states that it has no application to experience, although it clearly implies that in making an ethical choice we should pay more attention to the probable effects of the alternative courses of action in relation to the scientifically ascertained direction of evolution than to our own or other people's ethical intuitions or any system of ethical rules, etc.

The whole misunderstanding depends on the implicit adoption by Dingle of the traditional, and to my mind quite unsatisfactory, theory of the nature of an ethical aim as something absolute and without history. Thus, in a recent publication[2], he wrote: "It is clear that since the [ethical] principles of action must in essence be independent of the consequences of action, these latter being usually unknown, they cannot be expressed in terms of a rationalisation of past experience". Now the grounds advanced here for the independence of principles from their consequences are quite inadequate, since the consequences of our actions are never certainly known even when we guide them by an obviously empirical working hypothesis. One suspects that the independence is asserted merely on the basis of the introspection of an adult man who disregards entirely his own development. But however it has been arrived at, this view discounts at the outset the possibility of observing the genesis of aims, and thus any statement about their origin must appear non-observational. The apriorist view in fact becomes a tautology, since it has been smuggled into the discussion at the very beginning under cover of a theory of nature of aims in general.

It is, however, by no means impossible to observe the genesis, and thus the nature, of an aim; I mentioned in particular psychological and anthropological observations. The possibility of such a study has been overlooked in traditional thought partly because of the late appearance of an interest in evolutionary and developmental problems in general, and partly on account of the spurious 'absoluteness' of ethical aims, towards an elucidation of which both Prof. Huxley and I made suggestions. But it is the total neglect of such considerations which lies behind both the simple objections of Prof.

Joad and the more sophisticated ones of Prof. Dingle. It also robs of much of their cogency the discussions of Prof. Broad, to which Prof. Ritchie referred me, couched as they are in terms of non-developmental concepts of 'reason', 'emotion', 'pleasure', etc.

It is again an awareness of developmental considerations which I miss in Dr. Burniston Brown. The utilitarianism which he puts forward can, I think, be regarded as one of the historical forerunners of the line of thought which I suggested. His formulation, however, neglects all the advances made in our understanding in the last hundred years, and does not refute, or circumvent, the well-known difficulties of the theory. Thus he takes me to task for not defining my terms, and indeed the comments on my article show that in many cases I was not successful in indicating the subject of my remarks; but his first premiso seems to me untrue if 'pleasure' is defined in the ordinary way, and without significance if the definition is adjusted to make the sentence true. I think these difficulties are surmounted, and that Prof. Dingle's objection cannot be sustained, if, instead of saying that to achieve goodness we should strive for the greatest happiness of the greatest number, we state that our ideal of goodness is presented to us by a certain part of the personality, that the function of this part is the furtherance of evolutionary progress, and that the task of reason is to clarify that aim.

Dr. Childs is wrong in supposing that I "merely *defined* the good as that which tends to promote the ultimate course of evolution". In science one does not, except when teaching mechanics in an old-fashioned way to third forms, define concepts in the sense in which geometrical concepts are defined and which allows deductions to be made. A scientific definition, which I hope was the kind I was employing, consists in indicating the phenomenon which one intends to call by a certain name. What I did was to use 'ethics' in the first place for the ethical judgments of an individual. I then advanced three propositions about such judgments; first that they are a part of the super-ego, secondly that they are built up as a result of experience; and thirdly, that the function of the super-ego is to implement those aspects of the personality (such as those on which social life depends) which are the most recently evolved. My statement that "the direction of evolution is good simply because it *is* the good according to any realist definition of that concept" is a summary of those three propositions; I am sorry to find that it is apparently such a deceptive summary, but perhaps the critics might be asked why they always omit the latter half of the sentence.

That these propositions are real, and not fake, ones is made clear by the fact that they can be denied. Dr. Stephen, in her very interesting and constructive letter, raises certain difficulties about the first and third of them. As to the first, she points out the fact, which I should not dream of denying, that the demands of the super-ego do not always correspond with generally accepted ideas of the good. But I think one must, in spite of this, admit that what an individual's super-ego demands is what the good means to him, however it may contravene other people's principles. It is, however, the function of a rational theory of ethics to aid the ego in guiding the development of the super-ego, and for this we require a description of the good derived from a basis wider than the experience of a single individual, so wide in fact that it applies to mankind as a whole. I suggested that the nature of this wider basis becomes clear when we notice that (my third proposition above) the function of the super-ego is to subserve evolution.

It might seem that the existence of the "misguided super-egos" stands in the way of our acceptance of this third proposition; but that is not so. The existence of deleterious genotypes does not prevent us from realizing that evolution depends on the properties of genotypes; and the fact that some super-egos may be retrogressive should not tempt us to deny the evolutionary functions of that aspect of the personality.

Dr. Stephen does not take up this part of my thesis, and it is, I suggest, a consequence of that neglect that she is left without any criterion for identifying her 'good', 'healthy' tendencies. The spontaneous development of which she writes tends towards sanity only in those individuals whose super-egos are not too misguided; in other cases it ends in the mad-house or the gaol. It is in fact no more a criterion of good, from the point of view of humanity in general, than is the individual super-ego. But I think that when Dr. Stephen characterizes the good tendencies as healthy, she is approaching my point of view, since health means something very near to evolutionary fitness.

I am, of course, in entire agreement with her and Prof. Huxley that the conscious part of the mind (the ego) should exert itself to control, not only the physical mechanism of evolution, but, even more, the psychological mechanism, the fantastic, slap-dash character of which has rendered man's social evolution so miserably slow and full of set-backs. But until one realizes that this mechanism does produce evolution, one is not likely to be able to assist it in doing so.

I am in general agreement with the remarks of Dr. Darlington and Prof. Haldane[3], although the latter does not seem to have penetrated far enough into my essay to have discovered this. I also accept in general the thesis so ably argued by Dr. Needham[4], that the ethical principles formulated by Christ and the great ethical teachers are those which have in the past few thousand years tended towards the further evolution of mankind, and that they will continue to do so in the foreseeable future. This is, surprisingly enough, called in question by Dr. Childs in the second paragraph of his letter. He claims to be able to "point to the most highly organized community of modern times, based on quite other principles and methods". He does not do so, which makes his remark somewhat obscure; but I imagine that the community meant is Germany. The most charitable interpretation of such an unorthodox point of view is to suppose that Dr. Childs has become confused through using "most highly organized" first to mean "furthest advanced in social evolution" and second to mean "having the most rigidly formulative structure". Dr. Needham and I are, of course, both talking about the first sense, not the second.

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[1] NATURE, 148, 411 (1941).
[2] Dingle, H., *J. Aristotelian Soc.*, 122 (1939).
[3] NATURE, 148, 342 (1941).
[4] NATURE, 148, 411 (1941).

RESEARCH ITEMS

Early Uses of Iron

AN interesting article by H. H. Coghlan on early iron-working appears in *Man* (July–August). Among other points the author suggests that iron was not smelted as early as copper-tin (bronze), because without further elaborate treatment it was useless on account of its softness. It was not until the manufacture of what nowadays would be described as mild steel was developed that the product became superior to bronze, this manufacture having involved a more intricate knowledge of the processes of metallurgy, including particularly the use of tongs and the heavy sledge-hammer, than had at first been achieved.

Chinese Freshwater Medusa

A LITTLE more than sixty years ago interest was aroused among zoologists by the discovery of large numbers of a little freshwater jellyfish in the *Victoria regia* tank at the Royal Botanic Gardens, Regent's Park, London. The presumption was that, in some way or other, the medusæ came from South America along with plants of the Victoria water-lily. Since the discovery of these creatures was made by William Sowerby, director of the gardens named, they became known as *Limnocodium sowerbii* (Allman and Lankester). Arthur de Carle Sowerby contributes a short article on this jellyfish in the February issue of the *Hong Kong Naturalist* (10, 186–89). He points out that Ray Lankester named the genus *Craspedacusta* but that Allman a few days later suggested the generic name of Limnocodium which Lankester, in his subsequent writings, adopted. Priority of publication, however, demands the use of Lankester's original name—a point of view which Mr. Sowerby advocates. He gives data indicating that the medusa obtained in the Yangtze River in China, in 1907, is none other than *Craspedacusta sowerbii* although it was named *C. kawaii* by the Japanese zoologist Oka. The writer of the article referred to concludes that its original home is the waters of the Middle and Upper Yangtze River Valley whence it has from time to time been transported with perhaps the water-hyacinth (Eichhornia) to various parts of the world.

Larva of Ranina

HIROAKI AIKAWA ("Additional Notes to Brachyuran Larvæ", *Records of Oceanographical Works in Japan*, 12, No. 2, March, 1941) describes the first zoea of the crab *Ranina ranina*, hatched out in the aquarium of the Mitui Institute of Marine Biology. This proves that the curious larva figured by Claus (1876, 1885) as Acanthocaris is undoubtedly very closely related if not identical. Gurney has already placed Acanthocaris in the Raninidæ ("Bibliography of the Larvæ of Decapod Crustacea", 1939). The larva of *Ranina ranina* has affinities with the Brachyrhyncha on the one hand and the Anomura and Macrura on the other. Aikawa suggests that the Raninidæ should be grouped with the Dromiidæ and Homolidæ and now regards *Lithozoea kagosimœnsis* and *L. multispinosa* (Aikawa 1933) as larval Raninids. The larva of Dromia, however, differs so much from Ranina that a very close relationship seems improbable. Another crab zoea, hatched in the Misaki Marine Biological Station, belongs to *Macrocheira kœmpferi*. It is usually regarded as an Inachid, in the sub-family Inachinæ, but it is shown here to be nearer Hyas and Chionecetes in the sub-family Hyasteninæ of the Majidæ.

Diurnal Variation of Barometric Pressure

T. R. TANNAHILL has recently contributed an account of a new investigation into the diurnal variation of barometric pressure (*Proc. Roy. Soc. Edin.*, 61, Part 1, No. 7). The material analysed is a portion of the old records maintained on the summit of Ben Nevis (4,407 ft.), namely, the hourly pressure records for January and July 1884–1904. These are divided into clear days (mean cloud amount not greater than $\frac{7}{10}$) and cloudy days. It is pointed out that the diurnal variations found by Buchan and Omond in 1902 from the analysis of three years observations divided into similar groups differed mainly because of the method of selection, the tendency being for clear days to occur near the time of a barometric maximum and therefore on a convex part of the curve of pressure variation, and on the other hand for cloudy days to be more common near a barometric minimum when the curvature is concave, an effect to which attention was first directed by Bartels in 1927. Tannahill eliminates this effect in order to find the true diurnal variations by a method previously used by him and Robb when studying the lunar atmospheric variation at Glasgow, and finds that with one exception the differences from the normal variation obtained for all days regardless of cloud amount is insignificant except for the first harmonic for January, which shows an increase of $0{\cdot}123 \sin (x + 352°)$ millibars on clear days, x being measured from 1 a.m. This variation, although so small, is regarded as real, notwithstanding its absence from the corresponding data for July.

Ground Tilt at Wellington, New Zealand

TILTOMETER records made at the Dominion Observatory, Wellington, during the periods 1930–1934 and 1937–1939 have been analysed by R. C. Hayes and R. D. Thompson, and possible causes of the various movements discussed ("Ground Tilt at Wellington, New Zealand", by R. C. Hayes and R. D. Thompson, Dominion Observatory Bulletin, No. S-60, *New Zealand J. Sci. and Tech.*, 3*B*, 166*B*–182*B*; 1940). Most of the prominent movements recorded can be traced to meteorological causes, particularly temperature. In particular, the E–W component exhibits a marked diurnal wave which appears to be closely related to local ground-temperature changes at a depth of 1 ft. Normal day-to-day changes are controlled mainly by temperature, but appear also to be influenced to some extent by local precipitation. Occasional large tilts appear to be associated with abnormal meteorological conditions, particularly falls of snow or hail in the surrounding region. Other movements recorded consist of (1) a somewhat doubtful seasonal variation with a period rather less than twelve months; and (2) a general drift westward or south-westward during most of the periods concerned. The authors state

that they do not offer any satisfactory explanations for either of these movements, but they find that their evidence points to the westward or south-westward drift being a local movement, possibly due to settling of the Observatory building. No evidence of tilt due to tidal loading has been found. One of the principal objects in making tilt observations in seismic regions is to ascertain whether any pre-seismic tilts can be detected which might be of value in foretelling the occurrence of earthquakes. Considerable tilts have been observed to correspond with lava movements in volcanoes in Hawaii and Japan, and some tilts may be associated with movements of earth blocks with which also earthquakes have been associated. So far tiltometer records at Wellington have not shown any definite pre-seismic tilts or any movements which can be definitely attributed to tectonic causes. The authors suggest that a network of tiltometer stations may be of use in determining movements of earth blocks, or that single tiltometer records might be useful in thermal and volcanic regions such as exist in the North Island of New Zealand.

Reactions of Ozone

A STUDY of the separation of ozone from other gases and of the determination of ozone and nitrogen dioxide in the atmosphere has been made by J. L. Edgar and F. A. Paneth (*J. Chem. Soc.*, 511, 519; 1941). The separation of ozone in a concentration of as low as a few parts in a hundred million of other gases may be effected by the condensation of the ozone on the surface of a specially prepared silica gel at low temperature, when it is frozen out quantitatively. By raising the temperature it is recovered without decomposition, and by fractional evaporation it may be separated from nitrogen dioxide and hydrogen peroxide, the other oxidizing agents which might be present in air. The concentration of ozone so separated enables it to be identified by its ultraviolet absorption spectrum. The iodometric titration method of Ladenburg and Quasig was found satisfactory for the chemical determination of ozone. By making use of these methods, the ozone and nitrogen dioxide contents of some samples of air were determined. The ozone content varied from $0 \cdot 5$ to $2 \cdot 9 \times 10^{-6}$ per cent by volume, and when nitrogen dioxide was present its amount was of the same order. The state of the weather is given for each determination, but no very obvious correlation appears in the results (cf. Paneth and Glückauf, NATURE, 147, 614; 1941).

Crystal Structure of Alanine

THE difficult problem of the structure of proteins may be approached from the examination of simple amino-acid molecules, and a detailed X-ray investigation of *dl*-alanine $CH_3NH_2CHCOOH$ has been made by H. I. Levy and R. B. Corey (*J. Amer. Chem. Soc.*, 63, 2095; 1941), who give a full interpretation of the results with diagrams of molecular models. A brief statement of the many quantitative data given would be that the crystals are built upon an orthorhombic unit containing four molecules. The interatomic distances within the molecule are: C–O, 1·25 and 1·23 A.; C–C, 1·54 A.; C–N, 1·42 A. These give rise to important problems, discussed in the paper. The alanine molecules are linked together by a three-dimensional framework of hydrogen bonds, which is responsible for the abnormally close approach (3·64 A.) of methyl groups of adjacent molecules. The positions of the hydrogen atoms are fully discussed in terms of the intensity data and the results are structurally plausible. From the point of view of proteins, the great difficulty in selecting the most probable model from the many possible ones in the present state of knowledge is emphasized. The present results emphasize the probable importance of the directional properties of hydrogen bonds between nitrogen and oxygen atoms in determining atomic and molecular arrangements.

Periods of Eclipsing Binary Stars

H. HORROCKS has discussed the variations of the periods of certain eclipsing binaries (*Mon. Not. Roy. Astro. Soc.*, 101, 4; 1941). He has investigated the constancy or otherwise of the periods of a number of eclipsing binaries the periods of which are between 4 and 20 days. Oscillatory variations are suggested for *SY* Cygni and *W* Delphini; in the former, the period is about 2,000 orbital periods, that is, 30 years, and the amplitude is 0·07 day; in the latter, the period is about 3,600 orbital periods, or 50 years, and the amplitude 0·046 day. In the case of the three stars *RS* Canum Venaticorum, *SW* Cygni and *RT* Lacertæ, the periods of which are known to be variable, Horrocks suggests that the variations of period are due to oscillatory terms, but the observations at present available are inadequate to reveal their true character because the periods are long. Investigations carried out on six stars for which a variation of period has not been established showed that only two—*TT* Lyræ and *RS* Vulpeculæ—reveal rates of change of period with probable errors which are not excessive. The question of the rotation of the apse, due to a non-spherical form in the case of close components, or perhaps to the presence of a third body in the system, is discussed in connexion with four stars the orbital eccentricities of which are deduced.

Stellar Absolute Magnitudes

THE intrinsic luminosities of stars of different spectral types are now fairly well known where the nearer, less luminous, stars are concerned. The absolutely bright stars are usually so far away that calibration of spectroscopic surveys by means of trigonometric parallaxes is impracticable. This applies equally on one hand to the super-giants of all spectral types, and on the other to the early-type stars of all luminosities. Two recent papers by R. E. Wilson (*Astrophys. J.*, 93, 212; 94, 12; 1941) provide valuable information on the luminosities of stars in both these classes. The first paper deals with the non-variable *c* stars and establishes, from considerations of radial velocities and of proper motions, that contrary to previous belief their mean absolute magnitudes decline from − 5·4 for *cBO* to − 2·0 for *cK5* stars. Luminosities of the variable *c* stars, the Cepheids, are lower and run in the opposite direction. In the second paper Dr. Wilson deals with the stars of types *O5* to *B5* and concludes from a study of about 1,000 radial velocities and 1,500 proper motions that their luminosities fall from −3·7 for *O8* stars to −0·8 for class *B5*. These stars thus fit in well at the high-luminosity end of the "main sequence" and show that the known rise of brightness with temperature is continued among the hottest stars. The emission-line stars are not significantly different in magnitude from the others, whether they are members of the main sequence or super-giants.

ADRENALINE TREATMENT *IN VITRO* AND LIVER GLYCOGEN

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FOLLOWING the elucidation of the initial stages of glycogenolysis, largely due to the Coris and their collaborators, it has been possible to reproduce *in vitro* several processes known to influence the blood-sugar level and glycogen metabolism *in vivo*.

1. It has proved possible to give a biochemical basis to the homoiostatic function of blood-sugar level (Soskin) by showing that glucose *in vitro* regulates glycogen breakdown by inhibiting glycogen phosphorylase (Lehmann[1], Gill and Lehmann[2]). The glucose concentration needed *in vitro* was, however, somewhat higher than the normal blood-sugar level. There is another effect of glucose concentration *in vitro* which is fairly obvious but which we shall put into a quantitative form shortly.

The amount of glycogen formed by liver slices in an oxygenated glucose solution is greater the higher the concentration of the surrounding glucose, an optimum being reached at 3,000 mgm. per cent in rabbit and 4,000 mgm. per cent in rat. Higher concentrations are inhibitory, probably by damaging the cells.

2. The effect *in vivo* of asphyxia increasing the production of reducing sugar from glycogen is in part due to the absence of oxidative re-synthesis. It was possible, however, to show a marked increase of reducing sugar from glycogen and phosphate in dialysed muscle extract (that is, under conditions in which no re-synthesis takes place) when reducing agents were added (Gill and Lehmann[2,3]). The exact point at which this acts is the step at which Cori ester (1 ester) is transformed into the reducing Robison ester (6 ester). This precise step is inhibited by oxidizing and increased by reducing agents (Lehmann[4]). But taking into account the minor importance of this step for the production of reducing sugar in liver which is largely produced by a direct dephosphorylation of the Cori ester, and considering the fact that liver tissue is normally in a highly reduced state (Lee and Richter[5]), the effect of anoxæmia on liver may be almost entirely due to suppression of glycogen synthesis.

3. The action of insulin in preventing the breakdown of muscle glycogen has also been reproduced in muscle extracts (Lehmann[6], Gill and Lehmann[2]). Insulin inhibits *in vitro* the step in which Cori ester is transformed into Robison ester. The concentrations used, however, were much higher than those necessary *in vivo*.

4. Failure of storage of liver glycogen from carbohydrate food in suprarenal deficiency (Cori) was reproduced *in vitro* by demonstrating that liver slices of the adrenalectomized rabbit have a five times lowered power to synthesize glycogen from glucose as compared with normal tissue (Holmes and Lehmann[7]).

5. Injection of adrenaline first increases sugar production from glycogen in liver (Blum) and leads to a glycogen storage later on (Pollak). This after-effect has hitherto been thought to be due, not to the hormone itself, but to lactic acid accumulation in the blood resulting from the action of the hormone on the muscles (the "Cori cycle"). We have now been able, using physiological concentrations, to reproduce *in vitro* both the effect of adrenaline on sugar production by the liver cell and the increase of glycogen some time after the primary action. The old explanation for the first effect was that it deprived the liver of oxygen by contracting its arteries. Anoxæmia (as mentioned under 2) has in fact a glycogenolytic influence. The resynthesis of glycogen is an oxidative process and anaerobiosis disturbs the balance between the forces which keep the liver glycogen in a steady state. But the theory that adrenaline acted via an anoxæmia was disproved by Fröhlich and Pollak[8] in 1914 by showing the action of the hormone on the isolated frog liver under conditions in which its secondary effects such as anaerobiosis were carefully avoided. Since then, the general conception was that it acted by accelerating the glycogen breakdown as such. It has never been possible to demonstrate an effect in liver extract and liver brei. There is, however, a finding recorded by Cross and Holmes[9] that adrenaline—as they suggested by accelerating glycogen breakdown—prevented the appearance of glycogen in liver slices shaken with glucose. About as much adrenaline by weight per sample was needed, as glycogen formation was suppressed in a two hours experiment.

We want to record experiments which lead back to the old conception of adrenaline acting like asphyxia, though we no longer think that it acts by suppression of blood supply to the tissues. Three typical experiments showing the effect on glycogenolysis may be quoted.

GLYCOGENOLYSIS (MGM. GLYCOGEN LOSS/GM. LIVER) IN RABBIT LIVER SLICES SHAKEN IN KREBS RINGER BICARBONATE (TISSUE : FLUID, 1 : 6) 38° C. 30 MIN.

Initial glycogen (mgm./gm. liver)	95% O_2 5% CO_2	95% O_2 5% CO_2 *M.*/5000 adrenaline	95% N_2 5% CO_2
84·8	2·5	14·6	16·7
106·3	0 (+7·7)	11·5	11·9
59·9	11·8	18·3	17·9

These figures might suggest that adrenaline accelerates glycogen breakdown by preventing, like anaerobiosis, but not necessarily at the same stage, the resynthesis of glycogen. We observed the same effect on rat liver slices in winter. In summer, rat liver slices do not synthesize glycogen from glucose under the conditions of our experiments, and little difference was found in glycogenolysis in oxygen, oxygen plus adrenaline and nitrogen. So there is in fact a parallelism between an absence of glycogen synthesis and a failure of adrenaline to influence glycogenolysis. If adrenaline acts primarily on glycogen synthesis, no effect can of course be expected under conditions in which no synthesis can be demonstrated (for example in brei and extracts).

The reason that Cross and Holmes found no effect on slices at physiological concentrations is a twofold action of the hormone. Using a molarity of 1/200000 (which is 0·9 mgm./litre), a twofold effect can be seen if observations are made at several intervals of time. The treatment with adrenaline at first inhibits the synthesis of glycogen and later on increases it, thus masking the earlier effect. The following is a typical experiment.

SYNTHESIS OF MGM. GLYCOGEN PER GM. LIVER.

Liver slices from rabbit starved 39 hours (2·68 mgm. glycogen/gm. liver) shaken in Krebs Ringer bicarbonate (1 : 6) 95% oxygen ; 5% carbon dioxide ; 38° C. ; 0·5% glucose.

Time (min.)	Synthesis control	Synthesis *M.*/200,000 adrenaline	Effect of adrenaline (per cent)
0–120	9·00	8·35	−7
0–60	4·64	2·54	−45
60–120	4·36	5·81	+33

The synthetic effect can be shown best if slices are shaken with adrenaline for some time before the substrate glucose is added. Again a typical experiment may illustrate this point.

SYNTHESIS OF MGM. GLYCOGEN PER GM. LIVER.

Liver slices from rabbit starved 35 hours (0·55 mgm. glycogen/gm. liver) shaken in Krebs Ringer bicarbonate (1 : 6) 95% oxygen ; 5% carbon dioxide ; 38° C.

	30 min. 1 % glucose direct		30 min. 1 % glucose after 60 min. incubation without glucose	
	—	*M.*/100,000 adrenaline	—	*M.*/100,000 adrenaline
Synthesis	2·16	1·07	2·14	3·09
Influence of adrenaline	−50%		+45%	

(This work was aided by a grant from the Ella Sachs Plotz Foundation.)

[1] Lehmann, NATURE, 141, 470 (1938).
[2] Gill and Lehmann, *Biochem. J.*, 33, 1151 (1939).
[3] Gill and Lehmann, *Chem. Ind.*, 58, 254 (1939).
[4] Lehmann, *Biochem. J.*, 33, 1241 (1939).
[5] Lee and Richter, *Biochem. J.*, 34, 551 (1940).
[6] Lehmann, NATURE, 141, 690 (1938).
[7] Holmes and Lehmann, *Brit. J. Exp. Path.*, 21, 196 (1940).
[8] Fröhlich and Pollak, *Arch. exp. Path. u. Pharm.*, 77, 265 (1914).
[9] Cross and Holmes, *Brit. J. Exp. Path.*, 18, 370 (1937).

CONTINUOUS WAVE INTERFERENCE WITH TELEVISION RECEPTION

AN article by C. N. Smyth, of Kolster Brandes, Ltd., Sidcup, on continuous wave interference with television reception, is published in *Electrical Communications*, 19, No. 4 (1941). Interference with television reception can be very severe due to the large band width employed for this service, and is a much more serious problem than interference with sound broadcasting. Fortunately, however, both have much in common in the methods which can be used to effect suppression.

Interference is divided into two main categories: damped wave or impulsive type interference and continuous wave interference. The former is caused mainly by radiation from the ignition systems of motor vehicles, sparking in electrical machinery and appliances and from harmonics of spark-type transmitters on certain ships. Thermal agitation, noise in circuits and Schott noise in tubes also produce interference of this type within television receivers. The latter type of interference is caused by radiation from short-wave radio or television receivers, quite apart from any outside sources, due to unwanted couplings between certain circuits causing harmonics of the sound or vision, medical diathermy apparatus used in hospitals, and harmonics from powerful broadcast and amateur transmitters. Continuous wave interference patterns may also be produced within telephone receivers, quite apart from any outward sources, due to unwanted couplings between certain circuits causing harmonics of the sound or vision intermediate frequencies to react with the incoming signal, or due to hum voltages derived from the power supply frequency and its harmonics, or voltages derived from the harmonics of the scanning frequencies being injected into the receiver picture amplifier.

Interference-free reception of sound in television can only be effected if it is possible to locate an aerial where the signal-interference ratio is sufficiently large, and where the signal strength is sufficiently strong, to swamp the effects of losses in the transmission line and interference encountered in the receiver itself; then, providing the receiver is well screened and the power supply adequately filtered, the receiver will reproduce the signal-interference ratio present in the aerial in the frequency pass-band of the receiver. If the signal interference ratio is not sufficiently good, then advantage may be taken of the directional and polarizing properties of aerials, and an aerial employed which receives waves coming only from the effective direction of the transmitter, and with the desired angles of polarization. Beyond this, the signal interference ratio cannot be improved without reduction of picture quality, by reduction of band width or the use of interference suppression circuits which limit the peaks of picture modulation or leave gaps in the picture where interference signals would normally appear. Such interference suppression circuits are only applicable to impulsive type interference.

Further improvement lies in the direction of suppression of the interference at the source, but before this can be undertaken with any certainty of success, it is necessary to have an exact knowledge of the degree of suppression which is desirable.

By continuous wave interference is implied the production of spurious modulation frequencies superimposed on the picture signal in the output of the receiver, and appearing as a steady or slowly changing pattern on the picture screen. This effect is often described as a herring bone or feather pattern superimposed on the picture.

The annoyance value of the interference, that is, its property of destroying the entertainment value of a television programme, depends on the signal to interference ratio on the resultant picture, or what

is almost the same thing, on the output of the receiver revision amplifier or on the grid modulating device.

Mr. Smyth has made a series of visual observations and recorded them photographically to study the effects of interference on test signals and also on actual programmes. No marked divergence of opinion was expressed by any of the observers as to what did or did not represent interference-free reception. Measurements were also made to determine whether continuous wave interference was more noticeable by reason of its effect on synchronization rather than on modulation of the picture brightness. Several photographs are given which illustrate well the effects of change of frequency on interference.

The main conclusions which have been deduced from Mr. Smyth's observations and tests are as follow. Interference 40 db.(decibels) below the level of the picture modulation has no visible effect; at 30 db. below a slight effect is produced; while at 20 db. or less the entertainment of the picture is seriously reduced. The annoyance value of the interference is not affected by the brightness level at which the picture is reproduced provided the picture is reproduced with reasonable fidelity. A simple picture such as black lettering on a white background without any half-tones can be reproduced without appreciable loss of detail in the presence of considerable interference if the amplifier or light-source is over-modulated in both the black and white directions.

TEAK PLANTATION YIELD TABLES

RECENT research work exemplifies the close collaboration maintained between the Central Research Institute at Dehra Dun, India, and the local research officers maintained in the various provinces of the country. It also furnishes evidence of a wider connexion. The first yield tables for plantation teak were made by Bourne in 1919–21 for the Nilumbur teak plantation situated some forty-five miles up the Beypur River from Calicut on the west coast of Madras. This famous plantation was started by the collector of the district, Conolly, in 1844, and was for long regarded as the pioneer in this work. But in Java the Dutch had commenced to plant teak successfully at an earlier date; for in 1932 Dr. Wolff von Wülfing compiled some yield tables for teak plantations in Java which include trees up to one hundred and ten years of age.

Whether teak grown in pure plantations can ever equal in quality of timber the article produced when grown in a mixed forest, which is commonly Nature's own method, is perhaps doubtful. Owing, however, to the much higher price the timber fetches in comparison with that of its associates, it has been planted more extensively than any other single species ; and the cult has spread to Africa where it is an exotic. Existing plantations in India and Burma are now estimated to cover an area of roughly three hundred square miles, and about ten square miles are being added annually.

Until recently Bourne's Nilumbur yield table had been the only standard of reference available for teak grown in even-aged plantations. As it was based on growth measurements obtained from a single plantation it had considerable limitations in its application elsewhere. The Java 1932 yield tables were based on a greater range of quality and age; they were translated by Prof. H. G. Champion into English units[1]. It has been found that the tables recently compiled by the sylviculturist at the Research Institute[2] compare favourably with those of Dr. Wolff von Wülfing for Java ; height-growth trends and the intermediate quality class boundaries for both the Indian and Javan tables almost exactly coincide, thereby rendering it possible to make close comparisons between the data given in the two tables. The authors express their thanks to Dr. Wolff von Wülfing for his permission to reproduce his tables in English units.

[1] *For. Bulletin* No. 87 (1934).

[2] *Ind. For. Rec.*, New Series, Sylviculture. Yield and Stand Tables for Teak Plantations in India and Burma, by V. M. Laurie and Bakshi Sant Ram. (Gov. of India Press, Delhi 1940.)

FORTHCOMING EVENTS

SATURDAY, NOVEMBER 1

SOCIETY OF CHEMICAL INDUSTRY (Food Group) (Joint meeting with the South Wales Section) (in the Physics Lecture Room, University College, Cardiff), at 3.15 p.m.—Dr. Magnus Pyke: "The Chemical Determination of Vitamins".

MONDAY, NOVEMBER 3

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Sir John Russell, F.R.S.: "Reconstruction and Development in Eastern Poland, 1930–39".

TUESDAY, NOVEMBER 4

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 2 p.m.—Prof. Charles Edward Inglis, F.R.S.: Presidential Address.

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 2.30 p.m.—Mr. L. R. Braithwaite: "The Ileo-Gastric Syndrome" (Moynihan Lecture).

WEDNESDAY, NOVEMBER 5

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Edward Crowe: "Co-operation for Production".

THURSDAY, NOVEMBER 6

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 3.30 p.m.—Dr. W. E. Gye, F.R.S.: "Cancer of the Breast" (Imperial Cancer Research Fund Lecture)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ACTING HEADSHIP OF THE DEPARTMENT OF GEOGRAPHY—The Registrar, University College, Hull (November 6).

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, University, Bristol (November 8).

GRADUATE LECTURER IN THE ENGINEERING DEPARTMENT—The Secretary, North Gloucestershire Technical College, Lansdown Road Branch, Cheltenham (November 10).

INFORMATION OFFICER, who should be a graduate in applied science —The Manager, Wrought Light Alloys Development Association, 34, New Street, West Bromwich (November 15).

ORGANIZING SECRETARY—The Secretary, Association of Assistant Mistresses in Secondary Schools, Stoney Cockbury, Winchcombe, Gloucester (endorsed 'Appointment') (November 25).

RESEARCH ASSISTANT IN VETERINARY SCIENCE under the Alan, Duke of Northumberland Memorial Fund—The Hon. Secretary, King's College, Newcastle-upon-Tyne (November 29).

SENIOR GEOGRAPHY MISTRESS—The Headmistress, County School for Girls, Beckenham, Kent (endorsed 'Geography').

EDUCATION OFFICER—The Wardens, Educational Settlement, Pontypool, Mon.

RESEARCH ASSISTANT IN THE ECONOMICS DEPARTMENT—The Registrar, University College, Exeter.

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Nov. 8, 1941

INTERNATIONAL COMMODITY CONTROL

THE second Inter-Allied meeting, held at St. James's Palace on September 24, fully justified the hope expressed by Mr. Eden at the conclusion of the first, held on June 12, that the meeting might represent the inauguration of a new phase by which peace will be maintained after victory. This second meeting indeed owes its chief significance, not to the accession of the Soviet Union to its counsels or to the adhesion of the Allied Governments to the common principles of policy set forth in the Atlantic Charter, affirmed at the meeting, important as these may be, but rather to the agreement on concerted action for reprovisioning Europe after defeat of the Nazi regime. That agreement, together with the support and interest of the United States indicated in the statement Mr. Eden was authorized to make on its behalf at the meeting, afford weighty evidence that this time the United States and the individual allies will collaborate in the peace after the war has been won. The importance of American collaboration was indeed confirmed very emphatically by Mr. Sumner Welles in a speech delivered on October 5, in which he discussed the urgent need for plans for reconstruction and condemned the policy of restricted trade followed by the United States during the period between 1918 and the outbreak of the War.

The resolution adopted by the meeting affirmed the common aim of the Governments represented to secure that supplies of food, raw materials and articles of prime necessity should be made available for the post-war needs of the countries liberated from Nazi oppression. It contemplates the co-ordination of the efforts of the individual Governments on behalf of their own peoples, and pledges the Allied Governments and authorities to prepare the requisite estimates of kinds and amounts, and to indicate the order of priority in which delivery of the supplies is desired. Plans for the most efficient use of individual and Allied shipping resources are also envisaged, and as a first step the resolution proposes the establishment in the United Kingdom of a bureau with which the Allied Governments and authorities would collaborate in framing estimates of their requirements, and which, after collating and co-ordinating these estimates, would present proposals to a committee of Allied representatives under the chairmanship of Sir Frederick Leith-Ross.

In proposing this resolution, which implements the policy set out in the fourth, fifth and sixth points of the Atlantic Charter, Mr. Eden referred to preliminary work which has already been carried out under the British Government. In addition to the Leith-Ross Committee, a Ministerial Committee

on Export Surpluses has been established, of which the Minister without Portfolio is chairman. While these Committees have been in the main concerned with the arrangement of purchases, mostly within the British Empire, of commodities which have become surplus to current demand, and primarily to stabilize the economics of the territories concerned, they have been mindful of the value of such purchases as a potential relief store for the European peoples at present being ruthlessly denuded by Germany, and have also started inquiries as to probable human needs.

The framing and co-ordination of estimates of probable requirements is the first task, and the proposal for the establishment of a central bureau is intended to co-ordinate such estimates and provide a practical working approach to a survey of all needs on a common basis. Mr. Eden stated further that the Ministry of War Transport has already been considering what shipping might be available, and the proposed declaration on shipping policy is evidence that the mistake made in 1918 in abandoning immediately after the Armistice the Inter-Allied Food Council and the Allied Maritime Transport Council is unlikely to be repeated.

These developments hold real promise of the establishment of the effective central authority which is essential, and that the international co-operation in the economic field during the crucial period when 'first aid' is required will be built so far as possible out of organizations existing before the armistice. Nevertheless, the more distant horizon is beset with greater difficulties, which even now must be faced if long-range planning to meet such needs is to be possible. A successful attempt to discover means to overcome such difficulties may well depend on an early discovery of the best path to follow.

These reasons give pertinence and urgency to the plans outlined by Mr. Eden, as well as to a number of discussions of various phases of the subject which have recently been opened. Some attention to these problems was given at the recent British Association Conference on "Science and World Order", notably in Sir John Russell's brilliant paper on restoring the scorched earth and in Mr. W. L. Kelly's exposition of the ideals developed in Australia on the disposal of gluts of food as a remedy for trade depression. They have also received attention in Mr. F. L. McDougall's paper on "Empire Primary Products in Relation to Post-War Reconstruction", read before the Royal Society of Arts, and they are analysed in some detail in a P E P broadsheet on commodity control schemes.

Mr. McDougall, after reviewing the failure to improve economic conditions which led to the consideration by the League of Nations of the relation of nutrition to health, agriculture and economic policy, emphasized once more the futility of the Dominions concentrating upon economic nationalism. Reliance upon their own local markets offers no solution, and he suggested that in the word 'welfare' we might find the right and possibly the only solution of post-war economic problems. The Empire primary producer is vitally concerned in the third freedom of President Roosevelt—freedom from want everywhere in the world. He is directly concerned with food and raw materials of clothing, and his own vital interests require accordingly an economic policy in all countries directed towards higher standards of nutrition, housing, clothing and other factors of social welfare.

If at the same time we succeed in translating into action President Roosevelt's fourth freedom—freedom from war—with what it involves in relief from expenditure on armaments, Mr. McDougall believes that the nations would be able to devote a larger proportion of their resources to social welfare. He suggested indeed that the industrial nations will find that they cannot afford not to put a rising standard of living in the forefront of economic policy; and he pointed out that in India and in most of the British Colonies the internal problem also demands the reorientation of agriculture designed to secure plentiful supplies of health-giving food to the producers themselves.

Mr. McDougall's paper was delivered a considerable time before the historic meeting of Mr. Churchill and President Roosevelt, and is of particular interest as indicating the way in which opinion in the Dominions already recognizes its vital interest in the vision and policy of a *Pax oceanica* opened up in the Atlantic Charter. The *Pax oceanica* can no longer be maintained by Great Britain alone, and not the least significant feature of the Atlantic Charter is the evidence it affords that the United States is completing her evolution from a continental into an oceanic power. The Dominions are vitally interested in maintaining the *Pax oceanica* as the basis of world order and freedom, and it is clear that they are ready to recognize not merely this obligation, but also that it can only be pursued in relation to Continental Europe. The economic expansion of the Dominions can only be achieved through the raising of standards of living, which is a world-wide problem.

A policy tending towards the creation or re-creation of world markets, whether by developing the welfare of the Colonial peoples or by European reconstruction, involves co-operation in the creation of markets. It means making the consumer and not the producer the starting-point of policy; the organization of consumption takes precedence over the organization of production. The old

programme of freedom of trade is transformed into a new programme of freedom from want.

The policy of direct attack upon economic stagnation and social backwardness in the Colonies, like the idea of minimum standards in nutrition, health, social services and education stressed by Dr. Julian Huxley in "Democracy Marches", involves a new approach to commodity control schemes. As the P E P broadsheet shows, the existing schemes all imply some degree of conscious planning and co-ordination of action, and their development has been in the hands of pioneers whose ability and honesty of purpose have both varied. Even during the War, great advances are being made in the technique of economic control, and education in the uses and limits of control is being widely diffused. Much is being learnt from the almost world-wide application of 'lease-lend' procedure and the working out of shipping programmes for essential supplies, while the significance of organized research and planning in this field under Sir Frederick Leith-Ross is far-reaching.

The P E P broadsheet gives a concise analysis of the commodity schemes already in existence, their characteristic features and actual results achieved during the last twenty years. This analysis is inevitably much slighter than that in the report of the League of Nations committee for the study of the problem of raw materials, or in the Royal Institute of International Affairs information paper on raw materials and colonies. The most valuable feature of the broadsheet is accordingly its discussion of the purpose of commodity control and of the methods of establishing it, based upon the conclusions drawn from experience already available.

Despite the inherent disadvantages of commodity schemes and the frequent abuse of monopoly power, there can be no doubt that control has come to stay. Without its continuance, problems involved in the handling of world commodities by international co-operation after the War cannot be solved. Functional, as distinct from geographical or national, organizations are likely to play an increasingly important part in economic life, and it is important to learn the utmost from mistakes in the past, so that such functional bodies can be made fully accountable to the community as a whole by a strengthening of political authority—national and international. The commodity control scheme of the future, international in its control of supply and of markets, should be subject to public supervision and allow for a substantial representation of consumers.

This development should remove the two main criticisms levelled against past restriction schemes —the maintenance of prices at an unreasonably high level, and the persistence of inefficient production under restriction schemes. The measures now being taken to deal with the problem of surpluses, however, involve further problems. The holding of stocks on a commodity control basis affects the financial issue. Some means must be found of bringing finance into line if commodity control schemes are to function satisfactorily in the post-war period.

Now that Governments have entered the market as large-scale buyers, they are likely to continue to do so after the War, both for unwanted surpluses and for key raw materials and foodstuffs. One centralized Government organization which controlled the marketing of such products would be in a stronger selling position than a number of individual producers and mechants, and would also be able to ensure fair distribution. In schemes established after the War for commodities in which there are shortages, consumer interest will undoubtedly play a much more important part. So, too, the barter arrangement between the United States and the British Government holds possibilities for development in the post-war period, the main economic task of which will be to build up a system which is not subject to the violent fluctuations characteristic of the period 1920–39, but which stimulates a steady expansion of economic activity and makes adjustments possible with the least dislocation of economic life.

This task is parallel with the political task of building up a stable world order which fosters co-operation between nations. Control of the production and marketing of raw materials, if organized on a comprehensive international basis, is of the first importance in both tasks. Moreover, commodity control in such an economic order involves not merely eliminating past defects so as to make a reformed pattern of commodity control an accepted part of the economic structure. It involves also market surveys and forecasting of a comprehensive type, which are scarcely possible save under a strongly organized international scheme. It requires, too, a concerted effort to avoid the existence of surpluses of foodstuffs and raw materials at one point and shortages at another, which under commodity schemes before the War were frequently found in neighbouring countries. It involves also control over the industrial potential of every nation and therefore over its power to pursue policies of aggression, and the steady and continuous enforcement of peaceful measures rather than occasional belated attempts to stop wars.

Recognition of the economic and political objects of post-war commodity control leads Political and Economic Planning to suggest the formation of an international raw materials union for all commodities, built up on the lines of the International

Postal Union and affiliating the international and national associations controlling particular commodities. This union could be set up in the first instance by the Governments of the Allies and of the United States as a non-political body, the chief concern of which would be to promote economic welfare. Only key raw materials would be brought in at the start, and the union would not concern itself with particular commodities but with the general structure to be adopted in particular commodity control schemes and the terms of supply and of purchase to be observed by bodies affiliated to it.

One important function of the suggested union would be the publication of regular reports analysing trends in price and consumption of controlled commodities, indicating successful innovations for adoption elsewhere and defects to be avoided in future schemes. Common services, such as technical and economic research or exchange of personnel, would be organized by the various commodity controls for their own commodities, and by the union in respect of wider interests. The union would also promote co-ordination between the various commodity schemes in neighbouring groups of territories, for example, by creating regional reserve stocks, developing storage capacity, encouraging diversification in areas too dependent on one or a few products, and assisting exchanges of surpluses.

On the further question of the function of such a union in enforcing economic sanctions, the broadsheet merely indicates the possibilities, with a pointed reference to the measures which the United States and the British Commonwealth are belatedly taking against Japanese aggression. The suggestion is indeed too tentative to be judged in detail, but it does indicate the value of establishing some such union during the War, and the way in which it could facilitate the work of the International Reconstruction Commission which will assuredly be required afterwards in place of the unco-ordinated effects of individual Governments which proved so ineffective twenty years ago. The same basic idea has been outlined by Dr. Julian Huxley in "Democracy Marches", and it is implicit in the fourth and fifth points of the Atlantic Charter. No reader of the P E P broadsheet can remain unaware of the difficulties with which this problem bristles, but that they should be stated clearly and thoroughly discussed is the first step, not merely towards meeting immediate needs, but also to the long-term planning and co-operation upon which the reconstruction of world trade and the development of a new and more stable world order depend.

ONTOLOGICAL EVIDENCE OF DEITY

Mind and Deity

Being the Second Series of a Course of Gifford Lectures on the General Subject of Metaphysics and Theism given in the University of Glasgow in 1940. By Dr. John Laird. Pp. 322. (London: George Allen and Unwin, Ltd., 1941.) 10*s*. 6*d*. net.

PROF. LAIRD gives us here the second half of his recent Gifford Lectures (the first half having already been published under the title "Theism and Cosmology"). "Theism and Cosmology" was exclusively concerned with the two types of theistic proof "which appeal more directly to the scientific mind", the "cosmological argument" for a "great first cause", and the argument from design. The centre of interest in the present volume is different; we are concerned with the "ontological proof", which if valid would show that God's existence cannot be denied without flagrant self-contradiction, and the various forms of the "moral argument". The consideration of the latter leads to much interesting discussion of the sense in which omnipotence, benevolence, personality can be ascribed to God, and of the possibility of "pantheism". The conclusion of the whole matter reached in the final paragraphs is that while none of the theistic "proofs" is convincing or even highly plausible, theism is a tenable, though not demonstrably true, metaphysical theory of the universe which is more plausible than most of the possible alternatives. The verdict is the Scots "not proven" (which, by the way, commonly means that the jury knows pretty well what to think of the case). This finding will not satisfy all philosophical theists, though it should not perturb those of them who are Christians, familiar with the thought of faith as a *venture*, an assent of the mind to what is not forced on it by demonstration.

Few readers of NATURE will be likely to quarrel with the contention that the "ontological proof", whether in Anselm's version or in Descartes', is a fallacy which has been once for all exposed by Kant, and that its pretended resuscitation by Hegel is really a substitution of assertion for proof. I am not equally convinced by the reasoning of the chapters on "Value and Existence" and "The Moral Proofs of Theism". Prof. Laird is always fair-minded,

acute and critical, but he has not, I think, allowed sufficient weight to the simple but impressive argument from the unconditional validity and imperativeness of the moral law to a divine moral law-giver. It is not easy for me to believe that any confusion between the moral law of right and wrong and the edicts of a political superior can account for this felt imperativeness of a law which there is no political superior to impose, and with which political superiors are only too apt to 'play ducks and drakes'. Here, I believe, Prof. Laird might have learned more from Kant than he is willing to do ; I believe more attention to Kant would have made him a little suspicious of the merits of what he calls (in his chapters on "Providence" and "Pantheism") an impersonal theism. It is argued that if as a fact existence is on the whole a boon, and virtue and success, on the large scale, go together, this adequately safeguards all that is essential in the doctrines of divine benevolence and providence ; that the "impersonalist" would ascribe this result to an unintentional *trend* in Nature is a negligible detail. But is it ? The love and gratitude which are the proper response to intentional benevolence can scarcely be evoked by a blind trend except through a romantic illusion, and it is hard to see how our destiny can be apportioned to our inward goodness of will, unless, as Kant said, by a "reader of hearts".

I would remark also that in the subtle and interesting discussion of "pantheism" Prof. Laird is probably over-hasty in inferring from the language of Christian theologians about God's omnipresence in all His creatures that these theologians are with half of their minds asserting a pantheism incompatible with the theism of other parts of their teaching. Most of the theologians in question—perhaps all—would accept the scholastic principle that no predicate (not even existence) can be asserted univocally of God and of any "creature". If the pantheistic propositions quoted by Prof. Laird are read with this qualification, their meaning may be seriously affected.

I much regret that considerations of space compel me to be content with so inadequate a notice of a scholarly, candid and most acute study which I heartily commend to all readers of NATURE.

A. E. TAYLOR.

RELATION OF ONTOGENY AND PHYLOGENY

Embryos and Ancestors

By Dr. G. R. de Beer. (Monographs on Animal Biology.) Pp. x+108+2 plates. (Oxford: Clarendon Press ; London: Oxford University Press, 1940.) 7s. 6d. net.

IN 1930 Dr. de Beer published a small and stimulating book under the title "Embryology and Evolution". In it he attempted to reorientate general views relating to 'recapitulation' in evolution. Beginning with a statement of Von Baer's laws, he described their modification at the hands of Haeckel, who in his biogenetic law abandoned Von Baer's principles of progressive deviation and instead implied, as Dr. de Beer puts it, that phylogeny is due to the "successive tacking on of new final stages to the existing adult stages of animals". Haeckel's biogenetic law had, of course, come under considerable fire before Dr. de Beer attempted to redefine the problem. Its main shortcoming was the fact that the order in which characters appear in phylogeny is frequently completely different from that in which they appear in ontogeny. The term heterochrony is applied to this alteration in the sequence of stages.

The main purpose of Dr. de Beer's original essay was to show that variation in the order and rate of appearance of structures in successive ontogenies can have considerable influence on phylogeny. Thus, if a structure which normally appeared in the young stage of an ancestral animal appears in the adult stage of the ontogeny of a descendant, large structural changes occur without loss of plasticity, a process to which Dr. de Beer refers by the name of pædomorphosis. On the other hand, characters which normally made their appearance in the adult stage of an ancestral animal might appear in the young stages of a descendant, when they would cause little structural change but considerable loss of plasticity. To this process Dr. de Beer refers by the term gerontomorphosis. Dr. de Beer's conclusion was that pædomorphosis and gerontomorphosis "act intermittently in the phylogeny of the race, the former producing racial juvenescence, the latter racial senescence".

Dr. de Beer has now republished his original book, which has been out of print for some time, under the new title of "Embryos and Ancestors". He states in his preface that much new evidence has become available in the intervening years but that nevertheless he sees "no reason to alter the plan" of his former book "in the slightest degree". The same chapters are there, but some have been extended with more recent examples.. In its new form his book is just as stimulating to read as its

ancestor, and just as provocative. Some disappointment may be felt at Dr. de Beer's failure to consider some aspects of the problem in greater detail than he has done. The most striking instance of neotony which is usually emphasized is the view that man became differentiated from his fellow primates by a process of fœtilization, and it is this example of neotony which Dr. de Beer describes most fully. His arguments are the same as those which he presented in 1930, and are derived in the main from Bolk. Unfortunately Bolk's views on this subject scarcely stand up to close examination. It may be possible to recognize a process of neotony or fœtilization in human development if we are not too critical about the choice of the details of the developmental processes which form a basis of comparison between the development of man and that of non-human primates. It is, however, certainly impossible within the limits of the order of mammals to which man belongs to recognize an orderly process of increasing fœtilization.

While Dr. de Beer's lack of reference to such shortcomings of the general principles he discusses may be regretted, there can be no doubt that he has put the central issues of the general relation of ontogeny and phylogeny clearly and vigorously. His book will with little doubt influence a coming generation of biologists no less than did his earlier essay.

S. ZUCKERMAN.

A NATURALIST IN NORTHERN IRELAND

Birds of the Grey Wind

By Edward A. Armstrong. Pp. xv+228+32 plates. (London, New York and Toronto: Oxford University Press, 1940.) 12*s.* 6*d.* net.

IT is said that no Nature book can be successful nowadays unless its illustrations are good. "Birds of the Grey Wind" has a number of really excellent photographs. That of the fulmar in flight is outstanding, but almost as good are those depicting peregrine and sparrow hawk, sandpiper and water ousel. Of special interest is the photograph of a chough feeding her young. This is the first close-up photograph I remember having seen of a chough—a rare bird, nesting in the twilight of caves—and it is perhaps because of under-exposure of the negative that it has been necessary to touch up the bills of the young choughs. There is an unusual illustration showing a mute swan chasing away a Bewick's swan on Lough Neagh.

The book describes mainly the birds of Northern Ireland. There are chapters on Rathlin, Strangford Lough and Lough Neagh; on the heron and cuckoo, red-breasted merganser, swan and cuckoo. Mr. Armstrong writes clearly and sympathetically on the birds of his Irish home. He has spent long days and nights studying them, has watched the herons' flight into their wood above Belfast Lough, mergansers displaying in the sea on a calm November day, tree-creepers roosting in the gnarled bark of some great Wellingtonia, whistling choughs soaring with wide-open primaries above Rathlin, and a young cuckoo (an excellent series of pictures illustrates this) ejecting a hedge sparrow's egg from the nest. He has a leaning for the tales of long ago: Columba awaiting the arrival of the weary crane from Eire upon his spray-drenched island of Iona; Saint Patrick landing to preach the faith at Strangford Lough—surely Lough Cuan, the old name of that lough, signifies Lough of the Sea, and not, as Mr. Armstrong says, Harbour Lake!—and the fate of the Children of Ler who were compelled to ride the stormy sea for centuries in the guise of swans.

The book contains many interesting notes on birds. We are told that Irish magpies are believed (p. 20) to be the descendants of a flock of some dozen birds from England which were blown out of their course by an easterly gale and arrived exhausted on the Wexford coast about the year 1676; that two thousand wagtails roost (p. 8) in a certain tree in a Dublin street; of the nesting of a merganser (p. 109) on a tall conifer in the old nest of a grey crow. The story (p. 34) of a kestrel bitten and killed by a stoat it was carrying off reminds me of the fate of a golden eagle not far from Cape Wrath, which rose with a stoat to a great height, then fell lifeless to earth with a great wound in its throat, the stoat, strangely enough, unharmed after its strange experience. Mr. Armstrong (p. 7) believes that the moorhen never loses its timidity even when living with other birds that are tame. But I recall that at Fallodon there was a moorhen which used to take bread from Lord Grey's hand, almost as readily as his tame ducks.

There is one small slip in Mr. Armstrong's chapter on the great auk. He describes (p. 217) Stack an Armin as being in the Orkneys: it is, as a matter of fact, a high rock rising from the Atlantic just off Boreray, one of the St. Kilda group of islands.

SETON GORDON.

CONSERVATION OF NATURAL RESOURCES*

By C. H. Desch, F.R.S.

THE natural resources of the world fall into two main groups. The one, represented by the products of agriculture and forestry, may be renewed, either annually or at longer intervals, by cultivation, and may be consumed as income, while the other, including mineral wealth, must be regarded as capital, and once consumed is not renewed. Soils should perhaps form a third category, for while they may be maintained in fertility for thousands of years, as in China, they are only too easily ruined by careless or greedy exploitation, leading to exhaustion and erosion, or by mining operations, which may cause subsidence as in parts of England, or burial under debris through hydraulic mining as in California. This paper is mainly concerned with the conservation of those mineral resources on which modern industrial civilization increasingly depends.

Mineral deposits have too often been regarded as inexhaustible, and it is only lately that the possibility of exhaustion in a measurable time has attracted attention. As industrialization becomes more intense in Western societies and continually extends to regions which were purely agricultural, the rate of consumption of mineral capital is accelerated to an extent which is not always appreciated. Sir Thomas Holland has shown that in the first twenty-five years of the present century the quantity of minerals extracted from the earth was greater than that raised in the whole previous history of the world, or, say, six thousand years since copper was first mined. A report to a committee of the League of Nations in 1937 by Prof. Högbom gave diagrams which showed that over a period of about sixty years the annual production of coal doubled itself in a little less than seventeen years, of pig iron at about the same rate, of oil in eight and a half years, of copper in twelve and a half years, and of tin in eighteen years, the general trend remaining remarkably constant in spite of temporary fluctuations. Coal, for reasons which have been given by Sir Harold Hartley, ceased to increase after 1913, but in most instances, after an initial rate of growth which may be irregular, as for aluminium to-day, a stable rate is reached which gives a straight line when plotted logarithmically.

This does not mean that the production in any one country follows this law. The older producing regions may show a slower rate of increase, but this is compensated for by the opening up of new sources as the demand grows. It may seem impossible that such a fantastic rate of growth could long be maintained, but the standard of living which calls for such a consumption of metals and power applies as yet only to the Western nations. China consumes little metal, its enormous population depending on the use of renewable natural wealth rather than on mineral capital, but it represents a vast potential consumption, and the same may be said of India and, perhaps in a more distant future, of Africa.

It is extremely difficult to form an estimate of the existing mineral reserves. The total quantity of each element in the earth's crust, down to a certain fixed depth, has been estimated with some accuracy, and the figures are surprising. Nickel proves to be ten times more abundant than lead and fifty to a hundred times more than tin. Vanadium is more abundant than copper. But it by no means follows that they can be recovered in those proportions. For the most part, metals are very finely disseminated in the rocks, and extraction is only possible where local concentration has occurred through geological causes. Nearly 90 per cent of the world's nickel comes at present from a single great deposit in Ontario, and there are few other important sources. The deposits of tin are also highly local. The concentration which is necessary for profitable working varies very widely; thus the ore of the Rand may be worked when it contains one part of gold in 150,000, while hydraulic mining has been used on deposits containing only one part of gold in three millions. On the other hand, an ore containing 20 per cent of iron is of low grade.

The estimates of world mineral reserves given by standard authorities fluctuate from year to year, but there is a certain complacency in the statement regarding some important minerals that the reserves will last for several decades. Where essential capital, which there is no possibility of replacing, is concerned, we have to consider a more distant future. It appears that coal and iron may last for several thousand years, but the known reserves of oil, gold, tin and perhaps copper suggest a life of less than a century. That life may be extended in two ways: by the discovery of new deposits, or by improvements in methods of mining and extraction. The first is always possible, and there are regions such as the mass of ancient rocks in Canada still covered by

* Paper read at the Conference on Science and World Order on September 27.

forest which may prove to be valuable, but the areas unsurveyed are constantly dwindling, and there are vast regions which are mineralogically barren. By far the greater part of the mineral production of the world comes from countries bordering the North Atlantic, and ore deposits of importance are limited in the main to the fringes of the great oceans and a few mountain ranges.

It is, however, possible to improve greatly the methods of mining and of concentration. To take the latter first, the enrichment of sands and crushed rocks by mechanical separation is as old as mining itself, but it has been greatly perfected in the last century, and the introduction of new physical methods, such as magnetic separation, froth flotation (depending on surface tension) and electrolysis have made possible the working of ores of low grade. Further inventions of this kind may revolutionize the extraction of minerals, and in that case the estimates of the life of deposits now accepted may be too pessimistic.

Improvements in mining may make it possible to extract a larger proportion of the useful material from a given deposit, and this seems particularly likely in the case of oil, but it must be remembered that mining operations are usually wasteful. The extraction of the rich ore from a mine frequently renders inaccessible a larger quantity of ore of lower grade which it does not pay to bring to the surface. Under the usual conditions of exploitation there is a natural tendency to 'skim the cream' from a deposit, extracting only that material which is immediately profitable, and this is most likely to occur where a concession is being worked, perhaps in a politically unstable country, by a foreign company. This is one of the factors to be taken into account in a scheme for an international control of raw materials.

Each new technological advance is apt to create a fresh demand for some material, which may be of scanty occurrence. The electrical industry is much dependent on the unique qualities of certain varieties of mica, and the engineering industries call for steels and other alloys containing the rarer elements, such as nickel, tungsten, molybdenum, cobalt and vanadium. The light alloy industry is of very recent origin and has opened up great new fields of usefulness, and this again will in future make greater use of some of the rare elements. Little is known as to the available reserves of these metals, but the deposits containing them are usually small and are highly local. Some of them must be within measurable distance of exhaustion.

One possible mineral source as yet but little explored may be mentioned in passing. Owing to the disintegration of rocks by weathering and the transport of the products by water, all the elements present in the rocks are found in the sea. It is true that they are in an extremely dilute state, but recovery is not impossible. The fiasco of 'gold from sea water' of some years ago may seem to make this unlikely, but modern physical chemistry suggests possible means of concentration. Already magnesia is recovered from sea water in quite large quantities, the great volume of water which has to be handled not proving an obstacle.

Most minerals, once extracted from the earth, find application in industry, and after a period of usefulness which may be long or short become waste. Some of them, but not all, return in part in the form of scrap. Steel is made from pig iron, and until 1914 the world's production of pig iron was greater than that of steel, the balance being used in the foundry. In 1914 the curves crossed, and since then the production of steel has been greater, and increasingly so, than that of pig iron, owing to the very large quantities of scrap which are returned to the steel furnace. Not all of it comes back, corrosion and waste accounting for a considerable proportion. The use of recovered or 'secondary' metal, as it is called, is also becoming important in other metal industries, such as that of aluminium. Unfortunately, the key elements used in small quantities in alloy steels are largely lost, and it is here that a shortage is soonest likely to be experienced. Research is needed to devise means of recovering these essential and irreplaceable materials when the objects which contain them become scrap.

Much is now heard of substitutes for materials which have become scarce, and in Germany especially great efforts have been made to reduce to a minimum the quantities of metals used, such as nickel and tin, which cannot be produced at home, but it cannot be said that any startling success has been obtained in this direction. The new field of plastics offers genuine substitutes for metals for a variety of purposes, and as some of them can be manufactured from agricultural products they represent a real contribution to the cause of conservation.

There is one instance of a mineral which has been almost entirely replaced by an artificial product. Chile nitrate, for long the only source of artificial nitrogenous fertilizers, and occurring only in certain rainless districts of South America, where it had been formed under quite exceptional geological conditions, was clearly limited in its reserves, and its exhaustion could be foreseen. In 1898 Sir William Crookes, in a famous address to the British Association, painted an alarming picture of a decline in the supply of wheat owing to the exhaustion of soil nitrogen. Nitrogen compounds synthesized from the air have now replaced Chile nitrate, and the supply of them is inexhaustible. Radium, the

ores of which are very rare, is being supplemented for medical and similar purposes by artificial radioactive elements, but substitutions of this kind are obviously very exceptional In the main, we can only look to a more economical use of metals and to more complete recovery as a means of conservation. Another fertilizer, phosphate, is mainly derived (apart from that which is a by-product of the basic steel industry) from a few sources of limited extent, and our present highly inefficient means of dealing with sewage leads to the greater part of the phosphates being discharged into the sea. This is a form of waste which is closely linked with the general question of the fertility of the soil, and the problem will call urgently for a scientific solution in the very near future.

The case for a planned conservation of mineral resources may not seem so strong as that for energetic action to conserve soils and forests. Even minerals of which the known reserves are small may last for several generations. The future of the rarer and increasingly important elements is more difficult to foresee because of the imperfect survey so far made of their scattered deposits, but it is likely that the demand for them will increase more rapidly than that for the more common minerals. However, many of the errors of the past have come from lack of foresight, and a planned world economy must take account of conditions a century or more hence, when our descendants may find themselves hampered by the wasteful exploitation of natural resources in our own day.

That an international control of raw materials will be needed after the War is a natural consequence of such a promise as that of equal access contained in the fourth aim of the Atlantic Charter. A recent issue of *Planning* (P E P) has suggested a means by which such a control could be introduced, tentatively at first by application to a small number of commodities, the international raw materials union of producers including representatives of Governments in their capacity of consumers as well as producers. Such an authority would have many functions outside the scope of this paper, but as it would be in possession of the fullest information as to production, consumption and reserves it would be able to consider, in the light of that knowledge, the question of the possible exhaustion of reserves, and to recommend, or if its constitution should permit, to enforce, greater economy in use or a restriction of exploitation.

ECONOMIC ASPECTS OF THE BLOCKADE AND COUNTER-BLOCKADE

By PAUL EINZIG

THE relative importance of the economic factor among the factors determining the outcome of the War has increased considerably as a result of the progress in the mechanization of the armed Forces. Requirements of weapons and equipments of raw materials necessary for their manufacture and of motor fuel are now incomparably larger and more diversified than they were during the War of 1914–18. The striking power of the armed Forces is now dependent on the industrial capacity and the importing capacity of the belligerent countries to a much higher degree than in previous wars. The belligerent countries are now incomparably less self-sufficient than they were in the past. For this reason the duration and outcome of the present War depends to a very large extent on the results of blockade and counter-blockade.

It is essential to avoid exaggerating the relative importance of economic warfare ; but it is equally important to avoid going to the other extreme. The exaggeration of the relative importance of the blockade during the early months of this War was largely responsible for the slackness of Great Britain's war effort in other directions during that period. After the disillusionment that followed the German victories in Western Europe, the pendulum swung in the opposite direction, and for some time it was all but generally believed that economic warfare in general and blockade in particular was incapable of producing any noteworthy results. The truth lies somewhere half-way between the two extremes. In order to defeat Germany it is indispensable to win a decisive military victory. Such a victory is inconceivable, however, unless and until Germany's vital economic resources have been materially reduced as a result of offensive economic warfare. It is an equally essential condition of victory that offensive economic warfare waged by Germany in the form of counter-blockade and air bombing should be prevented from reducing Great Britain's economic resources.

The argument of those who underrate the importance of offensive economic warfare among our weapons against Germany runs broadly as follows :

The relative extent to which Germany's economic resources can possibly be affected either by air

bombing or blockade is moderate. Germany's industrial capacity is so vast, her plants and stocks are so widely dispersed over the territory of the Reich and of the occupied countries, that the R.A.F. would be incapable of destroying more than a relatively small fraction of these resources. As for the blockade, its significance has become materially reduced as a result of the acquisition of new sources of raw material through the conquest of the greater part of Europe, and as a result of the development of the production of synthetic materials. There is a great deal of truth in this contention. It seems an altogether hopeless task to try to reduce Germany's economic war potential in general by means of an economic offensive. On the other hand, it is by no means beyond the realms of possibility to reduce certain key resources of Germany.

During the earlier phases of the War it was hoped that the German war machine could be paralysed by concentrating upon the reduction of German stocks of oil, rubber, textiles and rare metals such as tungsten, molybdenum, wolfram, etc., required for hardening steel. In the meantime, this list became shorter, partly because Germany succeeded in seizing large stocks of special metals and partly because the necessity for concentrating on a small number of materials had become obvious. Indeed, in my own view, maximum results could be achieved by simply concentrating on oil. Assuming that Germany will be unable to seize the Russian oilfields—or at any rate that even if she should seize them they would be in a hopelessly damaged condition—there is every reason to hope that the British economic offensive would be able to paralyse the German war machine and economic system by bringing about a reduction of Germany's oil supplies. While in most other respects the blockade does not inflict upon Germany an intolerable burden, in respect of oil it is capable of preventing almost completely the arrival of consignments from outside Europe. Moreover, if the air offensive is concentrated upon the oilfields under German control in Poland, Rumania, etc., and on synthetic oil plants, refineries, storage tanks and pipelines, then Germany's producing capacity and stocks could be materially reduced. By pursuing such a policy, economic warfare would be made to play a decisive part in preparing the ground for military victory.

Hitherto we have confined ourselves to examining the possibilities of Allied offensive economic warfare against Germany. Let us now consider the problem of the defence against German offensive economic warfare. The British economic system has no Achilles' heel comparable to the German oil position, for the simple reason that so long as mastery of the sea is retained, deficiencies in particular materials can be made good by importing from overseas. For this reason, while German air bombing is capable of inflicting considerable losses upon life and property, it is in itself incapable of paralysing the British war machine and economic system in the same way as British air bombing is capable of paralysing the German war machine and economic system if concentrated upon oil production and supplies. The only way in which German economic warfare against this country could play a decisive role would be through cutting off Great Britain's lifeline. This is exactly the object of the German counter-blockade.

While Germany largely relies upon the production of food and raw materials of conquered Europe, Great Britain depends to an even larger extent on economic assistance from the United States and from the British Dominions. Neither of the belligerents is able to prevent the other from making use of these vast auxiliary resources outside their own territory. Judging by the progress to date of the Battle of the Atlantic, the German counter-blockade has so far failed to achieve this end. Judging by the expenditure of vast quantities of oil by Germany in the offensive against Russia, the results of the British economic offensive in the restricted sphere of oil have also been far from complete. These facts do not, however, prove that the economic weapon is of relatively small importance. After all, during the War of 1914–18, it took four years for the British blockade to produce its full effect upon Germany. It would be unduly optimistic to assume that the Battle of the Atlantic has been won and that Germany is entirely incapable of preventing Great Britain from benefiting by American and other overseas economic assistance; and the mere fact that certain statements concerning the effect of the British blockade on the German oil position have since proved to be at least premature does not mean that sooner or later the British economic offensive will not deprive Germany of her vital oil supplies.

Blockade and counter-blockade tend to produce a profound effect upon the economic structure. The result of the British blockade is an intensification of the German self-sufficiency drive, and its extension over German-controlled Europe. Under the necessity of war requirements many new branches of production are established and existing ones are expanded. The German counter-blockade affects the British economic system in a different way. It is true that in some respects self-sufficiency is aimed at in order to economize in shipping space. For example, in Great Britain food production tends to increase, largely as a result of the German counter-blockade. The same factor also works, however, in the opposite sense. It requires less

shipping space to import the finished products than to import raw materials required for their production. Partly for this reason many new plants have been established in the British Dominions in preference to their being built at home. In order to reduce the dependence of the British Forces in the Middle East and the Far East upon the lifelines from Great Britain, exposed as they are to German attacks, munition industries have sprung up in India, Australia and New Zealand. These Dominions are unable to depend on imports from Great Britain, and tend to become much more self-sufficient through the development of industries of their own.

The same is true concerning neutral countries. Lack of shipping space, among other reasons, prevents Great Britain from supplying her Latin-American markets to the same extent as before. The British blockade prevents these countries from buying manufactures from Germany, Italy, or other German-controlled industrial countries. Nor are the United States or Japan in a position to fill the gap. Consequently, blockade and counter-blockade leads to the industrialization of Latin-America. In any event, since the blockade and counter-blockade have made it more difficult for the Argentine, Brazil, etc., to sell their products either in German-controlled Europe or in Great Britain, they could ill afford to keep up their imports at pre-war level.

It seems probable that to a very large degree these effects of blockade and counter-blockade will be of a lasting nature. This was the case with the economic effects of the Continental system and the British retaliatory measures adopted during the Napoleonic wars, and also with the effects of blockade and counter-blockade during the War of 1914–18. It is true, there is a great deal of idealistic agitation in favour of free trade after the War. The fact, however, that by the termination of hostilities the degree of international division of labour will be much smaller than it was in 1939 will have to be borne in mind. Overseas countries will be reluctant to de-industrialize themselves. Most countries will be anxious to retain and develop industries required for national defence. As for Great Britain, the permanent loss of many of its overseas markets and the decline of its income from overseas investments will make it necessary to continue to produce at home more food than it did before the War. The task of 'unscrambling the eggs' by demobilizing new industries abroad and by letting the millions of newly sown acreage in Great Britain go once more out of cultivation will be more difficult than is generally realized.

The lessons learnt from experience in economic warfare during this War are likely to influence the peace terms. The victors will want to disarm their vanquished opponent not only in a military sense but also in an economic sense. The reversal of Germany's trend towards self-sufficiency would provide some safeguards against another war; a compulsory demobilization of some of her industries producing synthetic key materials would go a long way towards discouraging a repetition of 1914 and 1939, simply by rendering Germany more vulnerable to blockade.

SEISMOLOGY AND EARTHQUAKE-PROOF DESIGN

By Ernest Tillotson

On May 7, 1940, Mr. D. Laugharne Thornton read a paper on "Earthquakes and Structures" to the Royal Society of Arts[1], in which he stressed the need for the co-operation of engineers and seismologists for the purpose of mitigating the effects of earthquakes on buildings. Mr. Thornton's paper showed that engineers are fully alive to the situation, while the work seismologists have been doing to this end is perhaps not generally realized. Most of the work has been done with actual earthquakes, though much useful information has been obtained by the use of shaking tables and artificial earthquakes caused by dynamite explosions. (The results might be of immediate use in 'bomb-proof' design.) As Great Britain is an island in which strong earthquakes are rare, adequate results would not repay the setting up of strong-motion instruments, and most results have, therefore, been obtained in the United States and Japan. Mr. Thornton stated in his paper that "the first great earthquake in which scientists were ready with a wide distribution of instruments including some capable of recording strong motion, occurred so recently as September 1, 1923, at Kwanto, Japan". It may well be that the first adequate and reliable results for certain purposes were obtained then, though ever since the time when Milne and Knott were in Japan valuable information has been accumulating. Certain institutions and individuals have also long been obtaining noteworthy results in the United States, though it was late in 1932 when the U.S. Coast and Geodetic Survey inaugurated a programme of recording strong ground movements in seismically

active regions of the country to obtain data needed in the design of earthquake-resisting structures. The Survey has published much of the work, and the latest publication has recently been received[2].

Several types of strong-motion seismographs are used, but only the accelerographs and displacement meters give results of wide scientific value. These instruments do not operate continuously on account of the paper cost and the necessarily large speed of the record during the earthquake, but are automatically started through a pendulum-starting device by any earthquake which attains a certain strength. After a time the photographic record is automatically stopped. It is then removed and developed.

Seismographs are themselves pendulums especially devised for the purpose they have to serve. The accelerographs are so called because their period of 0·1 sec. is relatively short compared with that of the principal earthquake waves which cause damage, and therefore their acceleration is measured. The displacement meters have a period of 10 sec., and, since this is relatively long compared with the period of the principal waves in which we are interested, they record approximately the displacements. There are now thirty-five accelerographs in California, four in Arizona, four in Montana, one in Utah and one in the Panama Canal Zone. There are six displacement meters in operation, all in California, but each is installed near an accelerograph.

The positions of the instruments are important, since it is necessary to distinguish between ground movement and building movement. The accelerograph mostly used is more compact and satisfactory in operation than the displacement meter, and the chance of obtaining acceleration records is so much greater than that of obtaining displacement records that the former is often installed and the approximate displacements calculated. To do this the acceleration records are first enlarged and then, on the assumption of simple harmonic motion, these are integrated to obtain velocity curves which are in turn themselves integrated to give displacement curves. The mathematical principle is simple, but owing to the irregularities of earthquake motion there are many complications in the actual operations. These problems have all been solved, and in a private letter Dr. L. O. Colbert informs me that it is now the regular practice in his department to integrate the more important records, the others having to be omitted only because of necessity. Engineers are interested in all three sets of curves, namely acceleration, velocity and displacement.

In addition to the accelerographs and displacement meters several strong-motion seismographs of a type invented by Mr. Arthur J. Weed of the University of Virginia are in operation. This is an inverted pendulum device of period 0·2 sec. with oil-damping, and registers on smoked glass in three dimensions. The pendulum is always working, and when the vibrations become sufficiently intense a trigger action starts the clockwork which drives the smoked plates. Calibration is necessary. Since in the United States the various instruments are well distributed over the regions subject to earthquakes, a considerable number of records have been obtained, and all the principal earthquakes since and including the Long Beach earthquake in California of March 10, 1933, have produced records. The most informative records have been the three records of the Long Beach earthquake (one obtained in the business centre of Los Angeles), the records of the Imperial Valley, California, shock of 1934, those obtained for the shock at Helena, Montana, in 1935, and especially those of the earthquake of May 18, 1940, also in the Imperial Valley. The latter was of special interest as the instrument was only seven miles from the epicentre and a slightly greater distance from where there was slipping of 12 ft. along the fault.

Earthquake work in Japan is largely organized by the Earthquake Research Institute of the Tokyo Imperial University. Since the early part of 1939 economic depression has cut down the work of this Institute. Transport difficulties have also decreased the amount of information received from Japan so that the present state of Japanese seismology is somewhat unknown. Undoubtedly important work is proceeding there, as prior to 1939 great strides had been made. Early in 1931, Prof. Mishio Ishimoto perfected his acceleration seismograph, since which time it has taken various forms, all recording on smoked paper. The pendulum period is 0·15 sec. and the static magnification is about 200. An acceleration of 1 cm./sec.^{2} gives an amplitude on the record of 1 mm. There is a considerable number of these instruments in operation, but their present whereabouts are not known exactly since they are sometimes moved to get a better distribution.

The acceleration and displacement have in general proved to be greater than anticipated. For the northern California earthquake of September 11, 1938, the Ferndale accelerograph south-west–north-east component registered an earth wave period of 0·18 sec. with a maximum acceleration of 93 cm./sec.^{2} and a maximum displacement of 0·075 cm. This was not one of the great earthquakes of California, though the acceleration stated is above the average for 1938. Investigations at the University of California, California Institute of Technology and the Massachusetts Institute of Technology, have been made to deter-

mine the relation between actual damage and the measured motions.

One interesting utilization of the displacement curves is for the control of shaking platforms on which working models of buildings can be tested. This has been done at all the institutions mentioned, and photo-electric cell controls have been devised so that the motions can be closely reproduced. At the Massachusetts Institute of Technology the interesting experiment has been made of placing the accelerograph which recorded the Long Beach earthquake at Los Angeles on the shaking platform, subjecting it to the deduced displacement of that earthquake, and then reproducing the accelerogram. The reproduction, though not perfect, was quite satisfactory.

Since the destructive elements of motion are not fully known and are ascribed variously to acceleration, velocity, and period (because of resonance induced by the earthquake wave having the same period as the natural period of the structure) other observations are needed. The periods of thousands of buildings in various cities of California have been measured and are being analysed in regard to the type of building. It is proposed to re-measure the periods in selected types of buildings after a major earthquake. To measure the period the buildings are shaken by an eccentric fly-wheel device which is of variable speed, so that one of its periods corresponds to the natural period of the building. From the records, the period or periods of the building are readily obtained. The recording is done by a vibration meter, generally constructed on the principle of the Wood-Anderson torsion seismometer, or on a Neumann–Labarre vibration meter. Dominant ground periods have been reported from Göttingen, Germany, and Tokyo, Japan. In the United States a large-scale ground shaker has been built, but the high sensitivity Neumann–Labarre horizontal vibration meter and the Patterson vertical vibration meter show several distinct periods in California, none of which is dominant. It is recognized that a large earthquake might shake a thicker layer or layers of the earth's crust and thus produce a different period or periods. The general purpose of the work is to see whether a more logical method can be developed than that of providing in the buildings for a horizontal force equal to some percentage of gravity. Ten per cent is effective in Japan where the structures are simple and low, but it does not serve for the multitudinous array of buildings in California, or for all the other types of buildings in other parts of the world which are frequented by earthquakes.

Experiments have been made, mostly in Japan, in connexion with the vibration of various parts of a building. Records were obtained with a vibration meter orientated in various directions and placed successively on various floors of the steel-framed eight-storied tower and four-storied wings of the Imperial Diet building in Tokyo at various stages of construction, by Prof. Akitune Imamura. These showed that when the ground period was near 0·4 sec. the vibration was like that of a frame fixed at each end, whereas with a ground period approaching one second it was like a frame fixed only at one end. The former experiment suggested that the frames were too slender for their massive top load. The designers thereupon reinforced the weak parts of the building and thus increased the seismic stability of the structure. Prof. Katsutada Sezawa and Dr. Kiyoshi Kanai have subjected ideal cases to mathematical investigation and have found formulæ to represent the dissipation of vibrational energy. Fitting one of these formulæ to special boundary conditions, the greatest damage was found to occur in buildings at places where there was maximum bending moment as deduced from the formula. One building in their work is considered to be a circular cylinder constructed on a frame and having several stories. The columns in which the greatest bending moment is induced differ with difference in the value of $Ej^2\varepsilon/\mu l^3$ where E is Young's modulus of the structure, j is radius of gyration of the section, ε is radius of the structure, l is length of structure, and μ is elastic constant for earth. When $(Ej^2\varepsilon)/(\mu l^3)$ is 0 the columns in which the greatest bending moment is induced are those below the first floor. The larger the value of $(Ej^2\varepsilon)/(\mu l^3)$ the more the columns of floors still farther up partake of the greatest bending moment. In the limiting case where $(Ej^2\varepsilon)/(\mu l^3) = \infty$, the floor under consideration is that which is immediately below the roof or that a few floors below the roof. Friction in buildings may also damp down earthquake stresses.

Another distinct line of research has been pursued by the U.S. Bureau of Mines and other investigators, including Prof. L. Don Leet. When dynamite is used to shatter and remove rock, a by-product of the operation is the dissipation of a small fraction of the energy of explosion in the form of elastic vibrations which travel away from the blast through the ground. The types of waves have been studied in connexion with the geological formations through which they pass, and the dissipation of energy investigated. High frequencies (25–50) and short duration (about 0·5 sec.) are typical of records on rock. Lower frequencies (3–5) and longer duration (maximum observed in one set of experiments 23 sec.) are recorded on unconsolidated deposits particularly if the deposit exceeds twenty feet or so in thickness. The range of amplitudes for various distances and sizes of charge can now be predicted within limits which are narrow

enough to be of practical engineering value in estimating probable effects on structures.

In Great Britain very few earth tremors and no large earthquakes are experienced, but earthquake regions do exist in the British Dominions and Colonies, and British insurance companies often have interest in regions subject to earthquakes. It is well to point out that a body of information on strong-motion seismology does exist and that methods are available to those interested for the study of problems relating to the construction of earthquake-proof buildings. In various parts of the world building codes are in operation, and in such of these areas as are subject to earthquakes, buildings, bridges, dams and other structures financed in part or wholly from public funds, together with such structures as are built under the control of the authority, are designed in some measure to withstand earthquake stresses. It cannot be too strongly emphasized that this part of seismic science is progressing rapidly and that a study of observations obtained either from natural phenomena or from experiments, in addition to providing us with useful information, enables us to ask more intelligent questions in the future.

[1] NATURE, 146, 437 (1940).

[2] United States Earthquakes, 1938. U.S. Dept. Commerce, Coast and Geodetic Survey, Washington, Serial Number, 629, by Frank Neumann (1940).

PRESERVATION OF THE BRITISH FLORA*

By Dr. J. Ramsbottom, O.B.E.

MANY societies, leagues, associations and other bodies have concerned themselves in the past with the preservation of native British plants. The appeal is often made on æsthetic grounds. This is a sound policy, but occasionally it has seemed to get a little out of hand, and even sometimes to have defeated its object.

It is probable that far more damage is done by trampling down the plants than by picking the flowers. Many plants, as for example the common heather or ling, cannot endure trampling, whereas the effect of picking the flower of a bulbous plant is seen with daffodils and tulips every year in our gardens. Reasonable and careful picking of the commoner wild plants does little harm, and the joy that comes from flowers is one that it seems senseless to chide. It is really at bottom the spirit that prompts crowds to flock to Kew, Hyde Park, Bushey Park, Hampton Court, etc. This spirit should be encouraged in other directions.

Most of our attractive wild flowers are so abundant that little harm follows a reasonable amount of picking. The digging up of plants is a totally different matter. Plants with a successful method of reproduction such as bulbs, or corms, and perennial plants, do not disappear if only the flowers are removed: other plants suffer only in so far as there is a loss of seed production. But it is obvious that if plants are dug up there will be a gradual disappearance, no matter whether they are as prolific as are primroses and ferns in the south-western parts of England. Practically every civilized country has recognized the danger; in most there are societies which have laws prohibiting activities subversive to the welfare of the native flora.

In 1931 many societies, councils and institutes which are interested in various aspects of plant preservation elected representatives to the Wild Plant Conservation Board, which works under the auspices of the Council for the Preservation of Rural England. In 1914 the Selborne Society, through its Plant Protection Section, had prepared a Bill for presentation to Parliament, but legislative action was prevented by the outbreak of war. However, there is a good deal of scope provided by the Local Government Act of 1888, which empowers county councils to adopt by-laws for the preservation of wild plants.

Botanists and ornithologists have viewed with concern the effects of cutting verges and lopping hedges in country lanes. Here we meet with difficulties. The lanes must be kept tidy if on no other grounds but those of safety to users. There are various weeds which the Corn Production Acts say the farmer must destroy, and it is unreasonable to expect him, or roadmen, to carry out this obligation if botanical discrimination is added to the task. There are signs, however, that some county councils realize that there is no necessity for ruthless and indiscriminate cutting, or that spring or early summer is necessarily the period for the tidying process.

With rarer plants the problem is different. Some of these are unattractive to the non-botanist and are not likely to suffer except through excessive collecting. One or two are reputed to have vanished on this account, and the evidence from herbarium sheets gives support to some of the accusations that have been made.

* From the presidential address to the Botanical Section of the South-Eastern Union of Scientific Societies, delivered at Kingston-on-Thames on July 26.

On the other hand, some of the rarer plants are showy. An attractive plant may be protected because of surviving in more or less inaccessible places, such as the Cheddar pink. It seems to me that the only way to ensure the safety of others is to arouse a local interest in their protection. Local pride would do a good deal to preserve such rarities, especially if the habitats were known and the danger of extinction appreciated.

But there is also a wider problem which is not concerned with thoughtless or witless destruction. At the time of Cæsar's invasion of Britain we know that it was largely forest. During the Roman occupation much of the land was cleared and roads were built. With the cutting down of forests there is a difference in rainfall and always soil erosion, sometimes, as is more clearly understood in those countries which are paying the price, to the extent of causing deserts. When roads are made there is always an alteration to the drainage. With the building of towns cattle were put to pasture rather than driven from place to place. From all these processes at work there must have resulted an enormous influence on vegetation. I am not suggesting that any species were lost, though there might well have been. On the whole the number of species in the British flora is small; this is explained by the fact that more were not able to advance into Great Britain after the last retreat of the ice. The Channel has acted as a barrier to the invasion of plants from the Continent. If, therefore, any plant species were wiped out, that finished the matter; they did not come again.

The settlement by the Romans started changes which have continued to the present day. The old highways with their droves of cattle and wide expanse must have had an enormous influence on vegetation and consequently upon individual species. Later the spread of towns and the effect of smoke and other pollution consequent upon this have all had their destructive effect. The drainage of the Fens which began in the Middle Ages enormously affected the vegetation of the areas concerned. Neither must we forget the effects of farming, forestry and other forms of cultivation.

What we get as a gradual effect of civilization is an alteration in or a destruction of primitive vegetation. The change has taken place and most of it could not have been prevented even if this had been desirable.

As London extended, known localities of rarities were built over. Some of the habitats mentioned in the herbals now make strange reading. The one probably most quoted is that of the small bugloss given in Johnson's edition of Gerard's "Herbal", 1633, *Buglossa sylvestris minor* (*Lycopsis arvensis*)—"On the drie ditch-bankes about Pickadilla".

The lost habitats best known to London botanists are those of Battersea Fields, Chelsea Fields and Brompton Marshes, which disappeared as the Thames Embankment was built. A number of interesting species remain between Putney and Kew. Clusius, in his "Historia Plantarum Rariorum" (1601), records that the daffodil was "in such abundance in the meadows close to London, that in that celebrated village of Ceapside the country women offer the flowers in profusion for sale in March, when all the taverns may be seen decked out with these blossoms"; L'Obel (1605) also says, that in February and March the London flower-market is full of it.

Such losses are inevitable. As towns spread, especially in the old haphazard way, places famous as collecting-grounds from the time of the herbalists become just building sites to be developed. London has been fortunate in having royal parks and commons which are sterilized against such development; and a far-sighted policy reserved such forests as Epping and Burnham Beeches and is now organizing a green belt.

It is possible by sensible town planning not only to arrange proper means for fresh air and recreation for everyone, but also to prevent the sprawling ribbon development which has made some by-pass roads by-words. There are certain other consequences which it would be out of place here to mention. The point that can be legitimately made is that the countryside around such roads is ruined.

We are faced, however, with a much more serious problem at the present time as a direct result of the War. Aerodromes and military camps have multiplied over the countryside, and the carrying out of various exercises and other preparations for defensive or offensive war have made a sorry mess of some areas. I simply state the fact about our flora just as I would about the destruction of many famous buildings: it would be absurd to do more considering all that is at stake. Before the outbreak of war the Air Ministry paid due attention to the representation of those interested in different ways in the areas in which it was proposed to build aerodromes, and I understand that, even under the strain and stress of war, regard has been paid so far as is expedient to what is now popularly styled the amenities of the countryside. This enlightened policy is one of the most hopeful signs that we may look forward to the after-war period as one of 'reconstruction' in every sense of the word. It is obvious to everyone with eyes to see that there are a great many new blots on the landscape. After the War it may be that some of these will have to remain, but it should be a definite policy to remove, so far as possible, those which are no longer serving the purpose of national defence. Moreover, it may not be amiss to suggest that when an area is in occupation by H.M. Forces,

vegetation should not be wantonly or carelessly damaged. Trees which are knocked about, for example, do not invariably survive—and trees do not grow in a night.

Let us see to it that when salvaging our material possessions after the War we take care that our countryside is looked after.

When the time comes local bodies should make it their aim to get rid of all objectionable signs of war activity in their areas and they should be pressed to do so by local natural history societies. A derelict camp still with obvious signs of previous occupation is a sad sight, and does not improve with the years. Heaps of bully beef tins and other refuse left by our troops in the South African War are still to be seen in some parts of the Karroo. Organic material is soon dealt with by fungi and bacteria, but bricks, petrol tins and barbed wire are beyond their efforts.

In recent years there has been a strong movement on the part of several societies and associations for the establishment of national parks: roughly the objects they have in view may be classed as landscape preservation, public access and protection of wild life.

The idea of national parks seems to have been put forward first in 1832 by George Catlin, who suggested that the country around the geysers near the head of the Yellowstone River should be reserved as a public park.

The Yellowstone Park, sixty-five miles long by fifty-five miles broad, was reserved in 1872. The Oxford Dictionary defines a national park as "an extensive area of land of defined limits set apart as national property to be kept in its natural state for the public benefit and enjoyment". The definition is excellent so far as it goes, but there may be differences of opinion about the interpretation of the words "public benefit and enjoyment". The national park movement has spread rapidly in those countries where there are great stretches of unaltered vegetation. In Great Britain it is obvious that we cannot emulate Yellowstone Park, Jaspar Park, Kruger Park, that of Belgian Congo or those of Angola and the islands of the Gulf of Guinea now under consideration by the Portuguese Government.

What it is possible to do should be carefully considered—and then done Probably nowhere in southern England—though possibly in the north, in Wales and in Scotland—could we fix on an area sufficiently extensive to fulfil all the objects in view. But this does not mean that no attempt can be made to preserve tracts of countryside representative of our scenery. These tracts may be called national parks, or what you will; they should be sufficiently extensive and isolated not to suffer from suburban suffocation.

Recreation is a vital necessity for the public if there is to be real health of body and mind, but there is no reason why this should not proceed hand in hand with preservation. Sanctuaries could be set aside in the larger areas for preserving any species which need protection, in addition to smaller areas scattered about the country as nature reserves. If the public are educated up to it they will demand that such species be protected; education is more effective than *Verboten*—just as "Reserved for the protection of . . ." is than that wooden lie "Trespassers will be prosecuted". The way in which the general public obey some very annoying present-day restrictions gives ample proof of the fact that a law or regulation is the more powerful the more the reason for it is comprehended.

Strange as it may seem, it is often overlooked that it is the vegetation which is the key to the position. If plants are preserved then the scenery remains pleasant, and birds, animals and insects are for the most part safe. Perhaps the best way to appeal to the public is to make a point about the scenery: "Preserve the country's scenery"—and the rest follows. The general aim could then be stated as the desirability of preserving the various types of representative British scenery in sufficient numbers as to be reasonably accessible.

It is obviously impossible to sterilize a sufficiently large area in the British Isles to include all types of scenery or vegetation. The type of vegetation depends in the first instance upon the character of the soil, the altitude and the amount of rainfall, and as any large park or parks would need to be in a mountainous district we obviously cannot envisage such a park as providing an epitome of the country's vegetation. For that we must have several areas and, for special protection, areas set aside in these. No plan will succeed which attempts to exclude free access by the public. Those of us who know Richmond Park, Wimbledon Common, Burnham Beeches, Epping Forest and Virginia Water will have no qualms about the bad effect of open access to pedestrians. But it would be advisable to restrict motoring and horse-riding. Motoring brings obvious evils in its train, and those following excessive horse-riding in Epping Forest were causing an outcry in the last year or two.

The prevalent opinion seems to be that where areas are set apart for preservation Nature should be left to its own devices and then all would be well. In Switzerland each canton has its laws for the preservation of plants and there are several Nature reserves; there is also the Swiss National Park situated in the Lower Engadine. Here the following rules and regulations are in force. Human interference is absolutely excluded from

the whole region. Shooting, fishing, manuring, grazing, mowing and wood-cutting are entirely prohibited, no flower or twig may be gathered, no animal killed and no stone removed—even the fallen trees must remain untouched. In this way absolute protection is secured for scenery, plants and animals: Nature alone is dominant. Any one may visit the Park, but only simple Alpine shelter-huts are provided, no hotels being allowed to be erected. Camping and the lighting of fires is prohibited.

Some would like similar regulations made for any national park we might have. But it should be pointed out that only in areas of primitive vegetation is it possible to leave well alone and be certain that it will not alter. The vegetation of Great Britain as it is now is largely the result of interference; many of the types of vegetation are not as they would be if they were not controlled by various factors. So long as these factors remain the same, the vegetation remains the same. Taking it as a whole the vegetation of Great Britain is not static. For every type of soil there is a type of vegetation which is called a climax and there is a natural gradual change towards this. Everyone must have noticed hawthorn and other bushes 'invading' grassland adjoining woodland, but it is not always realized that this is a natural process leading to the climax vegetation—for forest is the climax.

The idea is often expressed that "Education of the average adult to respect our wild flowers may seem well-nigh hopeless. He is not interested". Certainly the normal place for beginning education is the school, and much can be done there to inculcate a proper appreciation of our native scenery and the duty of preserving vegetation from spoliation. But education does not end at school, and the B.B.C. and the cinema have brought home to many an interest in green things growing.

When the present War is over it is possible that eventually there will be many changes in our normal mode of life. Maybe some benefit other than speed will accrue from the increase in the use of mechanical devices. To one not versed in the refinements of economics the conclusion seems justified that if work is done more quickly by fewer men there must either be unemployment or shorter hours. We certainly had unemployment before the War, and in the future reconstruction we may well look for shorter hours for those engaged in manual labour, though not I fear for the rest of us. If this desirable state of affairs eventuates, we are then faced with the basic problem of education, how to spend one's leisure time.

When leisure time is short, sports and spectacles are sufficient as relaxation for most; but with longer periods of freedom normal people will need something in addition. Some will doubtless be attracted by the study of natural history. Men and women of the Forces and evacuee children will be unlikely to be content to stay put, and we shall probably have a greater number exploring the countryside than ever before. Let us have wide open spaces, call them what you will, let us keep them so that they will ever show what Great Britain was by showing what she is, let us realize that it is to the community's interest to preserve wild life, be it plant, bird, animal or insect: then when we have the same pride in our natural possessions as we have in our race we shall have gone far along the way to preserving our flora.

OBITUARIES

Mr. W. H. Caldwell

WILLIAM HAY CALDWELL died at Morar Lodge, Inverness-shire, on August 28. In the 'eighties he was notable as an original young Cambridge zoologist who had revolutionized the process of cutting paraffin sections. Born at Portobello in 1859, he went from Loretto to Gonville and Caius College, Cambridge, in 1877, and attended Francis Maitland Balfour's lectures on animal morphology. He was scholar of his College during 1878–83, and obtained a first class in the Natural Sciences Tripos of 1881, beside Walter Gardiner the botanist, who survived him three days[1]. Research on the development of Phoronis occupied his first graduate year, which was marred by Balfour's untimely death on the Alps (July 1882)—thirty years old and of world-wide reputation.

Adam Sedgwick, aged twenty-seven, manfully faced the task of carrying on the school founded by Balfour. Balfour's professorship had been created for him and died with him when he had held it seven weeks; so when as a freshman I entered the new Morphological Laboratory, just completed by the University for Balfour but never seen by him, Sedgwick, Trinity lecturer, presided over it. Caldwell was appointed University demonstrator of comparative anatomy in succession to J. J. Lister; Sedgwick and Caldwell, with fourteen-year-old "John" for laboratory boy, forming the entire staff.

So I found the advanced lectures on invertebrates being delivered by an attractive young man, on the tall side of middle height and well made, with finely cut features, fair wavy hair and a carefully twisted little fair moustache; this was Caldwell. On the

bench in front of me he was faced by about eight third-year men—the very best third-year that Cambridge zoology has ever known—only two years junior to himself. He had a charming deprecatory smile, which I saw first then as he faced these fierce young critics. Lecturing was not his *forte*, but I carried away a vivid recollection of his lectures on his own work, shortly before he read his "Preliminary Note" to the Royal Society[2].

This paper made some stir. The effects have not all disappeared of his argument, from the well-known metamorphosis, that the long axis of the worm-like Phorŏnis is dorso-ventral, and that this appears[3] "to furnish the explanation of the relations of the surfaces in Brachiopoda, Polyzoa and perhaps the Sipunculoid Gephyrea . . . Caldwell's views were accepted by Lankester in the 9th edition of this work [*Enc. Brit.*], the Phylum Podaxonia being there instituted to include the groups just mentioned, together with the Pterobranchia". MacBride[4] concluded in 1914 "that Polyzoa Ectoprocta alone can be regarded as having affinities with Podaxonia, and that Polyzoa Entoprocta cannot be included in this group as defined by Lankester". So, after a third of a century, the new proposal of this first paper was still a matter for lively discussion.

During his research, Caldwell was cutting paraffin sections one day with a transverse razor on Jung's microtome: two or three sections stuck together in line. "I say," said Caldwell to Weldon, looking on, "if we could make them all stick together, we should have the whole larva on one strip !" He devised the plan of coating the hard paraffin with soft paraffin, and so was born the ribbon method of cutting sections. He asked Threlfall of Caius (afterwards Sir Richard Threlfall) to study the Jung and design a similar microtome to be worked by a water motor, with a travelling band to carry the sections. This was constructed and set up in the Balfour Laboratory, where it worked constantly and successfully for half a century; a version for sale is described and figured in the *Quarterly Journal of Microscopical Science* as "The Caldwell Automatic Microtome"[5]. Threlfall told me that this latter was technically inferior—some question of centres of gravity, I think, and the five-point support; he had a second example of the original made for himself because he was proud of it as a perfect machine. Caldwell busied himself over the question of the razor's edge; I saw him once heating a razor red-hot over a Bunsen and plunging it into cold water: he explained that he tempered the razor as soft as possible before honing it and then tempered it absolutely short before using it, so as to have the edge as stiff as possible. He discussed the possibility of getting very thin sections by freezing both blade and paraffin during the cut.

In 1883 Caldwell was appointed the first Balfour student, to study, as Balfour had suggested to him, "the development of the peculiar Australian Mammalia and *Ceratodus*". As student he received £200 a year for three years—extended to a fourth year—and the Royal Society furnished £500 for equipment from the Government grant. He was made a fellow of Caius before he left for Australia, which he reached in September 1883. With camps on the Burnett River and elsewhere and laboratory at Sydney, he obtained much marsupial and monotreme material and complete series of the development of Ceratodus. He sent home two papers for the *Quarterly Journal of Microscopical Science*[6,7], and on August 29, 1884, he telegraphed to the British Association at Montreal: "Monotremes oviparous ovum meroblastic"[8], a much noticed telegram which at first astonished and puzzled newspaper readers in the cryptic confusion of "Caldwell finds monotremes viviparous ovum blastodermic"[9]. But on Tuesday, September 2, the President (Moseley) was able to assure Section D that no "more important telegram in a scientific sense had ever passed through the submarine cables . . . these mammals laid eggs and the development of those eggs bore a close resemblance to the development of the eggs of the Reptilia; proving that those animals were more closely connected with the Sauropsida than with the Amphibia"[10].

By December 1886 Caldwell had finished and sent home the first instalment of his *magnum opus*: "The Embryology of Monotremata and Marsupialia. —Part I". On January 27 he married Margaret Gilchrist, daughter of Mr. J. B. Watt, of Sydney; they sailed for England, where, on March 17, he read to the Royal Society the paper he had sent home[8]. It describes, with three coloured plates, the ovum and egg-membranes of Echidna, Ornithorhyncus, Phascolarctos and Hypsiprymnus; prefacing the description with a brief narrative of his studentship.

This "Part I" in the *Philosophical Transactions* ends Caldwell's contribution to biology. He and Mrs. Caldwell came to Cambridge and in 1888 bought "Birnam", a house in Chaucer Road. A room at the laboratory housed his collections, on which he worked for many years, but no further biological papers have ever appeared.

About 1893 he left Cambridge and zoology to become a paper-manufacturer in Scotland (I believe that an uncle left him the paper-mill). He resumed possession of his house for a short time in 1904, but was not in Cambridge for the meeting of the British Association in the Long Vacation. He stayed by his mill, away in Inverness-shire, and was scarcely ever seen in Edinburgh; he had ceased to be a member of the Savile Club in London already in 1896. A writer in *The Times* of September 19, 1941, states that "several of his methods for increasing the sensitiveness of photographic emulsions have been adopted . . . while his work on paper-making processes also had practical application . . . he gave much of his time to biochemical work, and especially to the chemistry of the enzymes and digestion . . . at the beginning of the last War he was attached to the staff of the 1st Highland Mounted Brigade, and later on took up the problem of vaporising heavy oils for internal combustion engines, and also the manufacture of acetyl cellulose". There is some published work by Caldwell on vaporizers and steam-generators, but no papers on enzymes, emulsions, or any other subject by him is known to physiologists, biochemists or colloid chemists.

In 1937 he asked Prof. Reinhard Dohrn for a

table in the Zoological Station at Naples; I think he stayed there a year. Making some inquiries from me before starting, he gave a most keen and enthusiastic description of what he was going to do (something biochemical based on something he had done already, in Paris if my memory serves).—"Where will you publish?" "Oh, there is a lot to be done before there is any question of publication." This was at the age of seventy-eight.

He died at eighty-two leaving three daughters; he lost his son in the War of 1914–18.

My own guess is that he had early set himself an impossible ideal of perfection and completeness in scientific papers; in the 'eighties we were still labouring under the illusion of monographs which should be final. It is possible that, when Caldwell found after five years work at Cambridge that he could not write a definitive and perfect treatise, he grasped at the chance of a new life and rid his scientific conscience of the burdensome duty of publication. Henceforward he worked at varied scientific problems for his own intellectual pleasure or financial profit.

He was undoubtedly gifted with good powers of observation, easy mastery of technique and a capacity for clear reasoning and incisive writing. Much was hoped of him by his seniors, particularly Foster and Adam Sedgwick, and Sedgwick was a great friend. Sedgwick in 1910[11], summarizing the results of biological expeditions, cites that "of W. H. Caldwell to Australia (1883–1884 [*sic*], discovery of the nature of the ovum and oviposition of *Echidna* and *Ceratodus*)". That represents his friend's summary of Caldwell's contribution, after 1883, to zoological knowledge.

But let all biologists always remember that they owe the ribbon method of cutting paraffin sections to the twenty-two-year-old William Hay Caldwell, brilliant bachelor scholar of Gonville and Caius College. G. P. Bidder.

[1] Nature, **148**, 462 (1941).
[2] *Proc. Roy. Soc.*, **34**, 371 (1882).
[3] "Enc. Brit." (1911); "Phoronidea" by S. F. Harmer, p. 473.
[4] "Embryology" (Invertebrata), 1914, p. 406.
[5] *Q.J.M.S.*, **24**, 648, unnumbered plate (1884).
[6] *Q.J.M.S.*, **24**, 655, Pl. 43 (1884).
[7] *Q.J.M.S.*, **25**, 15, Pl. ii (1885).
[8] *Phil. Trans.*, B, 463 (observations and conclusions, pp.470–79) (1887).
[9] "Alumni Cantabrigienses" (Venn) *sub* Caldwell.
[10] Report Brit. Assoc., 1884, p. 777.
[11] "Enc. Brit." (1910), "Embryology", 328*a*.

Mr. H. Standish Ball, O.B.E.

Harry Standish Ball was born in South Africa in 1888 and died at Haslemere after a long illness on September 26. He was a distinguished mining engineer with wide experience of South African and American methods, and during the War of 1914–18 became one of the recognized authorities on military mining. But it was his work as principal of that famous School of Metalliferous Mining at Camborne (Cornwall) by which he was best known to mining engineers.

Ball spent his school days in Johannesburg and obtained his early technical instruction at the Transvaal University College, where he won many prizes and supplemented his theoretical work by a thorough practical training in the gold mines of the Witwatersrand. Afterwards he went to McGill University, where he graduated in the Mining School. On returning to South Africa he obtained employment in various official capacities in the mines, thereby laying the foundation of his knowledge of practical mine management.

Shortly after the outbreak of war in 1914, Ball joined the Royal Engineers (Tunnelling Corps) and served throughout in France, ultimately becoming commandant of the First Army Mining School and technical military mining instructor to the American Expeditionary Force. He wrote several official treatises on military mining, was mentioned in dispatches four times and awarded the military O.B.E.

After the end of the War in 1918, he returned to South Africa, where he held various mining appointments, and during 1921–33 held posts in South Africa and South America, and made many reports on mining and oil properties in these countries as well as in Canada.

In 1933 Ball came to England and was appointed principal of Camborne. The School has long been famous as a training centre for metalliferous mining engineers and, being situated in the heart of the Cornish mining-field, the students have great opportunities for studying the art as well as the science of mining. Before Ball's time some critics considered that too much attention was paid to the practical side, and the new principal, with a sound background of scientific knowledge, recognized this. He set to work slowly and methodically to revise the syllabus, raise the entrance standard and improve the training during the course. His methods were most successful, and he had the satisfaction before the commencement of his last illness of seeing the reputation of the School of Mines raised to a higher plane than it had ever attained.

Besides possessing great technical ability, Ball was an able administrator and in himself a charming man and delightful companion. His death is a sad loss not only to his old students all the world over, but also to his innumerable friends of maturer years.

J. A. S. Ritson.

We regret to announce the following deaths:

The Right Hon. Lord D'Abernon, P.C., G.C.B., G.C.M.G., F.R.S., on November 1, aged eighty-four.

Prof. W. F. Ganong, emeritus professor of botany in Smith College, Northampton, Mass., known for his work on plant physiology and botanical education, on September 9, aged seventy-seven.

Sir Arthur Hill, K.C.M.G., F.R.S., director of the Royal Botanic Gardens, Kew, since 1922, on November 3, aged sixty-six.

Dr. Victor Jollos, formerly associate professor of zoology in the University of Berlin, known for his work on heredity and mutation, on July 5, aged fifty-four.

Dr. J. S. Plaskett, F.R.S., director of the Dominion Astrophysical Observatory, Victoria, B.C., Canada, during 1917–35, on October 17, aged seventy-five.

NEWS AND VIEWS

American Mathematicians and the U.S.S.R.

The Soviet Embassy in Washington has recently received for transmission to Soviet mathematicians a statement of solidarity signed by a number of their most distinguished American colleagues. The document carries signatures of ninety-three mathematicians of forty-seven American universities and colleges. Prof. Marston Morse, president of the American Mathematical Society, is a signatory, as also are eight past presidents of the Society. Fourteen are members of the National Academy of Sciences. Among the signatories are several well-known German mathematicians who now reside in the United States and who know from personal experience the destruction Hitler has wrought in German culture. These include Profs. E. Artin, R. Courant, W. Mayer, H. A. Rademacher and O. Szasz.

The statement reads as follows: "We ... send our greetings and express our heartfelt sympathy to our colleagues of the Soviet Union in their struggle against Hitler fascism. What the future of mathematics would be in a Hitler-dominated world we know from the unprecedented destruction of mathematics in Germany after the advent of Hitler. We are deeply impressed by the heroic stand of the Soviet peoples and know that the mathematicians of the Soviet Union are doing their part in this supreme effort. The bonds between mathematicians in the United States and the Soviet Union are particularly strong since during the past two decades the center of world mathematics has steadily shifted to these two countries. We know many of you personally and more of you through your scientific writings. We know that you are fighting alongside your fellow-countrymen in their brave struggle against the invading tyrant and we assure you that we here are doing everything in our power to aid all peoples struggling against fascism. With best wishes for a successful fight against the evil forces of fascism, we remain, fraternally, your colleagues in the United States."

Commonwealth Grant to Australian Universities

Under the Australian federal system, public education is a function of the State Governments, and the six universities look to these bodies for financial support. Five years ago, however, the Commonwealth Government undertook a share of this responsibility by providing £30,000 a year to meet costs of research in the natural sciences and in economics, and of training young graduates in research technique. The funds are administered by the Council for Scientific and Industrial Research in consultation with the Vice-Chancellors' Conference. The Commonwealth has now announced its intention to raise its contribution to £40,000 a year, commencing in 1942, on condition that at least £9,000 a year be devoted to social science studies bearing on problems of post-war reconstruction.

American Anthropology

Anthropological Papers, Numbers 13–18, have been recently published by the Smithsonian Institution (Bureau of American Ethnology, Bulletin 128). These include "The Mining of Gems and Ornamental Stones by American Indians", "Iroquois Suicide", "Tonawanda Longhouse Ceremonies", "The Quichua-speaking Indians of the Province of Imbabura", "Art Processes in Birchbark of the River Desert Algonquin" and "Archæological Reconnaissance of Southern Utah". The last of these, by J. H. Steward, will appeal especially to archæologists interested in the ancient history of the New World. The article is based on the surveys of Judd (1926) and Steward (1933 and 1936), and deals with a culture apparently based on that of the Basket-maker Pueblo peoples of the San Juan River basin. A large number of sites were visited and are described, and the material culture found in them is catalogued and illustrated. Painted pottery, naturally, occurred as well as flint implements. It is a pity, however, that these latter are so inadequately figured—mere outlines of the tools being all that is given. An interesting series of rock-drawings was also discovered, showing conventionalized figures of animals and human beings, as well as signs of various kinds, including the spiral.

Indian Jute Production

A brochure containing much valuable statistical material on the jute trade and industry, including estimates which are not available elsewhere, has been issued by the Indian Central Jute Committee, Calcutta, under the title "World Consumption of Jute" 1938–39 and 1939–40 (Economic Research Bulletin No. 1, R.1, 1*s*. 6*d*.). The estimates of the total consumption of jute in the world given in this bulletin for the period 1933–34 to 1939–40 indicate that consumption reached its peak in 1936–37 with an aggregate consumption of about 123 lakhs of bales, but world consumption in 1938–39 fell to 107 lakhs of bales, and only rose again to 109 lakhs of bales in 1939–40, in spite of the hectic buying at the beginning of the War. Independent estimates of the yield of the jute crop are also included for the 1938–39 and 1939–40 seasons.

The War has seriously affected the export of raw jute, but this was more than compensated by the rise in the export of jute manufactures, the countries within the British Empire considerably increasing their consumption of Indian jute manufactures, although there was a substantial reduction in the normal commercial demand for jute goods. The consumption of raw jute by the Indian mills fell in 1938–39 but increased considerably in 1939–40, and the total stock of raw jute for the Indian mills was 20 lakhs of bales at the end of 1939–40, or about 9 lakhs of bales less than the stock at the end of 1937–38. The total yield of the jute crop in the 1938–39 season was a little more than 80 lakhs of bales, which was less than the world total demand

for the year by 17 lakhs of bales. The yield of the crop in 1939–40 was more than 109 lakhs of bales and the jute crop of 1940–41 is expected to give a record yield of 125 lakhs of bales. The consumption of raw jute this season is likely to be abnormally low, and a considerable quantity of jute is expected to be left over from the crop of 1941. The bulletin embodies the results of investigations carried out by the Economic Research Sub-Section of the Committee.

Cements for Glass Inserts in Electrical Apparatus

THE fixing of glass or porcelain insulators to metal parts by means of cement in the construction of switch gear and other apparatus has been a practice employed since the early days of electrical apparatus. At one time a mixture of sulphur and ground glass was extensively used for porcelain, the well-known litharge and glycerine cement being employed for the finer classes of work. This latter material is still in extensive use, but much work is also done with cements of the calcium sulphate type. As certain new products of this latter class have been introduced, an investigation has been carried out by the British Electrical and Allied Industries Research Association in order to elicit information bearing on the performance of these materials in practice (Technical Report, Ref. *G./T.* 131, "Recent Experience with Calcium Sulphate and other Types of Cement for Glass Inserts in Flame-proof Enclosures". By A. P. Paton). A table is given in the report summarizing the information collected on the quantities of cement mixed at a time and used for each article, and the time necessary before the articles could be released from the jigs. The latter varied from a maximum of 48 hours to a minimum of a quarter of an hour. This latter figure was exceptional and referred to meter glasses and windows fixed with Hawkins iron cement. A minimum period of $\frac{1}{2}$ hour was given for flame-proof lighting fittings and cover glasses of housings fixed with C. Fine Keene's cement. The figures, however, varied somewhat and were not closely connected with the type of cement. In one case it was stated that $2\frac{1}{2}$ lb. of gum arabic to a gallon of water was used in making up C. Fine Keene's cement. No difference in strength was found, and the cement adhered more firmly to glass or metal.

In certain conditions, C. Fine Keene's cement may give rise to electrolytic action if used with Bakelite. This cement is essentially an anhydrous calcium sulphate, which is slightly acid, due to the addition of a small percentage of alum. The presence of this potassium salt is considered undesirable when the cement is in contact with insulation of the synthetic resin impregnated type. Alternatives which have now been developed are termed Kaffir Plasters. They consist of calcium sulphate hemi-hydrate and are manufactured by Messrs. Cafferata. The product hydrates almost fully within about two hours, so that 'dry out' is almost impossible. The report states that it is a little unfortunate that the word plaster conveys to the general public the idea of a product which is inferior in strength and performance to a 'cement'. Actually, it is technically accepted in the gypsum trade that a cement is a high-temperature dead-burnt product, and that, without exception, all hemi-hydrates are designated plasters. The specially prepared hemi-hydrates known as Kaffir Plasters, while chemically similar to plaster-of-Paris, are different in their mechanical and physical properties, and give strength figures many times higher than those of plaster-of-Paris. They harden rapidly, and jigs may be fixed in 2–3 hours.

Health of the Sudan

IN his recently issued report for 1939 Dr. E. D. Pridie, director of the Sudan medical service, maintains that in spite of the occurrence of epidemic diseases, especially cerebrospinal fever, relapsing fever, smallpox and measles, the health of the Sudan in that year was very satisfactory. The epidemic of cerebrospinal fever which broke out in Equatoria and was not suppressed by the end of the year, comprised 2,714 cases with 647 deaths—a fatality-rate of 25 per cent against an expected rate of 60 per cent. The mortality at the onset of the epidemic was 80 per cent, but treatment with drugs of the sulphamide class reduced it to about 10 per cent. There were 1,000 cases of relapsing fever with 92 deaths, and 502 cases of smallpox which originated in French Equatorial Africa. On the other hand, the incidence of typhoid fever and bacillary dysentery was low. Although the range of most of them was limited, practically every endemic tropical infection was present in some part of the Sudan.

Earthquake in Alaska

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentre of the earthquake of July 30, 1941, which took place at 1 h. 51·5 m. U.T. This was at latitude 60·9° N., 149·2° W. which is very near the railway between Seward and Anchorage, Alaska, and about midway between these two places. It is not known whether or not there was any damage due to the earthquake. Alaska and the Aleutian Islands form part of the circum-Pacific ring of instability, around which earthquakes and tremors are fairly frequent. Recently earthquakes have been very frequent among the Aleutian Islands, and what was probably the most notable earthquake of recent years on the mainland occurred on April 26, 1933, to the north-west of the Kenai Peninsular. (NATURE, May 27, 1933, p. 757.)

University of London

DR. H. L. EASON retired from the office of principal on September 30 and Mr. Harold Claughton entered upon his duties as acting principal on October 1.

The title of reader in geography in the University has been conferred on Dr. R. E. Dickinson, in respect of the post held by him at University College.

The degree of D.Sc. has been conferred on the

following: Mr. W. P. K. Findlay (Imperial College of Science and Technology), Mr. P. L. Hsu (University College), Mr. Louis Hunter (Queen Mary College), Mr. R. A. Kekwick (University College), Mr. A. R. Martin (Imperial College of Science and Technology) and Mr. J. R. Nicholls. The degree of D.Sc. (Engineering) has been conferred on Mr. W. K. Wilson.

Dr. Timothy Richards Lewis (1841-1886)

DR. TIMOTHY RICHARDS LEWIS, a pioneer in tropical medicine and medical parasitology, was born on October 31, 1841, at Llanboidy, Carmarthenshire. He received his medical education at University College, London, and qualified at Aberdeen in 1867. He entered the Army Service at Netley in 1868 and successively held the office of assistant surgeon, surgeon and surgeon-major. After working for three months with Max von Pettenkofer at Munich, he went with his friend D. D. Cunningham to Calcutta in 1869, and for the next ten years collaborated with him in the study of cholera and other Indian diseases. In 1870 he gave the first authentic account of amœba found in man, and in the same year described *Filaria sanguinis hominis*. In 1878 he described the non-pathogenic form of trypanosoma found in rats. In 1883 he was made assistant professor of morbid anatomy at Netley, and in 1885 he was appointed honorary secretary of a committee convened by the Secretary of State for India with Sir William Jenner as president to investigate Koch's discovery of the cholera bacillus. He was recommended by Council for the fellowship of the Royal Society, but died on May 7, 1886, before this honour was conferred upon him. At the time of his death he was carrying out an extensive series of cultures and inoculations of bacilli in the human alimentary canal.

Jean Victor Audoin (1797-1841)

JEAN VICTOR AUDOIN, an eminent French entomologist, was born in Paris on April 27, 1797, the son of a lawyer. His early interest in natural history prevented him from following his father's profession, for which he was first intended, and he took up medicine, qualifying in 1826 with a thesis on the natural history and the chemical, pharmaceutical and medical aspects of cantharides. He had already in 1823 founded with J. B. A. Dumas, the chemist, and A. Brongniart, the geologist, the *Annales des Sciences Naturelles*. In 1824 he became assistant to H. Latreille, professor of entomology and director of the Natural History Museum in Paris. In 1832 he was one of the founders of the Société Entomologique de France, and in the following year succeeded Latreille. In 1837 he was elected to the Paris Academy of Sciences in the Section of Agriculture. His best-known investigations were carried out with Milne-Edwards on the anatomy and physiology of Crustacea, and on the parasites of the vine and silk-worm. He died on November 9, 1841. At a meeting of the Academy of Sciences on August 13, 1844, D. Gruby gave the name of *Microsporum* (afterwards changed to *Microsporon*) *Audouini* to the fungus causing ringworm of the scalp, a term still in current use, in recognition of Audoin's having directed attention to parasites which destroy the living tissues of animals.

Comets

Comet van Gent (1941 *d*). The elements of an orbit of this comet, and an ephemeris, assuming parabolic motion, have appeared in NATURE (148, 139, 370, 530; 1941). Davidson and Sumner have computed a new orbit, using the observations of Mr. W. T. Hay at Hendon, and have found that it is slightly hyperbolic. Another orbit will be computed, using later observations of Hay, and as these extend over a period of a month, August 29–October 3, it will be possible to give a definite pronouncement on the nature of the orbit.

Comet du Toit-Neujmin. This comet was discovered by du Toit at Bloemfontein on July 18 and also independently by Neujmin at Simeïs. Its magnitude at the time of discovery was 10. The aphelion of the orbit lies close to the orbit of Jupiter and the last close approach to the planet probably occurred in 1824, when the planet may have annexed it as one of its family. The elements of the orbit, computed by H. R. H. Grosch, are given below, and also an ephemeris.

T	1941. July 21. 18766 U.T.			Ephemeris		1941.0
ω	69° 10′ 33·3″	1941·0			α	δ
Ω	229 37 07·2	1941·0	Nov. 6	22h.	40·5m.	−4° 34′
i	3 14 49·4	1941·0	14	0	52·3	3 55
a	3·095176		22	23	03·9	3 10
e	0·5789569		30	0	15·6	2 20
P	5·4456 years.					

The geocentric and heliocentric distances on November 30 are 1·89 and 2·3, respectively. As it is receding from the earth and sun, it is becoming fainter.

Periodic Comet Schwassmann-Wachmann (2), 1921 *l*. This comet has been discovered by Dr. H. M. Jeffers at Lick Observatory, its magnitude at the time of discovery, September 20, being 17. In "The Handbook of the British Astronomical Association, 1941", there is an ephemeris based upon the orbit computed by Mr. W. P. Henderson and Dr. H. Whichello, planetary perturbations being taken into consideration. The comet was discovered almost exactly in the predicted place, a discrepancy of only 18^s in the right ascension occurring.

New Asteroid. Harvard College Observatory Card No. 606 has announced that an object, probably a new asteroid, has appeared on the 40-in. reflector plates used at the U.S. Naval Observatory. An orbit will be computed later.

Announcements

THE Lord President of the Council has appointed Sir Franklin Sibly, vice-chancellor of the University of Reading, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. The Right Hon. Viscount Falmouth has retired from the Council on completion of his term of office.

ERRATUM.—In NATURE of October 25, p. 479, the Lawrence referred to was not, of course, T. E. Lawrence (of Arabia), but D. H. Lawrence.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

A Mendelian Situation in the Birthcoat of the New Zealand Romney Lamb

DR. T. M. OLBRYCHT[1] finds it difficult to believe that our N-type coat[2] can have a comparatively simple genetic basis. That conclusion was adopted very tardily here, as papers published show[3,4] and, as stated before, we have bred a few N-type animals in which, from breeding data, the genetic basis is regarded as multifactorial. In these animals, we suspect, the factors responsible interact to produce very high abundance of halo-hairs in geometric, not just additive, fashion. The early experiments dealt in differences in the abundance of halo-hairs on the back of not-N lambs, and revealed strong multifactorial inheritance. Lambs are graded by eye when not more than a few days old. N-type has one halo-hair to an average of about nine curly-tip fibres. In not-N six grades are distinguished, ranging from no halo-hairs at all in Grade I to one halo-hair to about 200 curly-tip fibres in Grade IV, and one to about 27 in Grade VI. Lambs of high Grade VI may be called borderline-N, and for our present purpose all Grade VI lambs are called near-N. There is good evidence, strengthened in 1940, that some near-N animals carry the same factors for N-type as typical N-type sheep of our 'mendelian' stock. In determining ratios, N and near-N are counted together, but it will be seen that the near-N lambs are few compared with the N-type. We now give the results up to 1940 most pertinent to the point at issue.

Mendelian ratios. On mating together N or near-N animals which from their parentage we regard as heterozygous (for an N-complex on one chromosome) there have been born 42 N, 4 near-N, 1 V, 4 IV, 2 III, 4 II, 3 I. This gives 46 N and near-N combined and 14 not-N; a good 3 : 1 ratio.

In back-crosses of N and near-N deemed heterozygous, put to mates with no or few halo-hairs on the back (Grades I and II) or of unknown grade (supplied by the College Sheep Farm and virtually certainly not-N), we have obtained: 146 N, 35 near-N, 7 V, 8 IV, 37 III, 110 II, 50 I. N and near-N together number 181 against 212 not-N. On testing this departure from equality we find $\chi^2 = 2{\cdot}45$. On our present hypothesis a slight excess of not-N is in fact expected on account of crossing over between closely linked duplicate factors. The scarcity of lambs of intermediate grades in these back-crosses affords good evidence for the simplicity of the genetic situation.

Homozygous rams. Four N-type rams, with both parents N-type, but with one grandparent on each side not-N, were back-crossed in 1940. One proved heterozygous, siring 6 N, 1 near-N, 12 not-N. Three had families containing only N and near-N lambs, the individual results being: 14 N, 1 near-N; 14 N, 1 near-N; 7 N. Another N-type ram bred in a way that need not now concern us was back-crossed in 1940 and sired 28 lambs, every one of them N-type. These four homozygous rams clinch our argument.

Monofactorial explanation inadequate; suggested comparatively simple hypothesis. The results presented may suggest a single dominant factor. Things are not quite so simple, as we realized earlier, and we have further to report that an N-type ram which, in experiments referred to in our previous communication, mated with not-N ewes not its own daughters, had sired 2 N and 57 not-N, all of low grades, was mated in 1940 with its own daughters. Its lambs were 6 N, 1 near-N, 6 not-N. This is taken to be a 1 : 1 ratio.

We are used to changing our views, and we may be right or wrong in now postulating two pairs of linked duplicate factors, with two doses necessary to give N-type, and any two doses able to produce N-type unless there is present a suppressing factor, which we think exists, but is scarce. Our point is that the genetic situation is a relatively simple one.

F. W. DRY.
J. A. SUTHERLAND.

Massey Agricultural College,
Palmerston North,
New Zealand.
June 4.

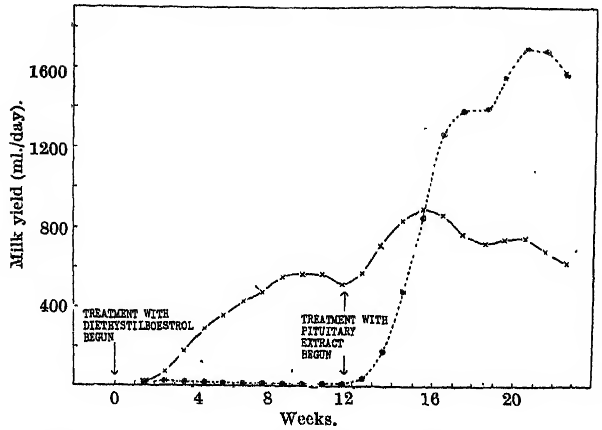
[1] NATURE, 147, 57 (1941).
[2] NATURE, 145, 390 (1940).
[3] *N. Z. J. Agric.*, 46, 1 (1933); 47, 5 (1933).
[4] *J. Text. Inst.*, 26 (1935).

Artificial Induction of Lactation in Virgin Animals

THE discovery by Folley and his co-workers that treatment with diethylstilbœstrol alone will induce copious lactation in virgin goats[1] and heifers[2] has recently been confirmed for the goat by Lewis and Turner[3]. Since the administration of a crude extract of ox anterior pituitary gland strikingly stimulates the milk production of the cow during the normal decline of lactation[4], it was of importance to determine if the production of milk resulting from treatment with diethylstilbœstrol could be further increased by injections of anterior pituitary extract.

Two nulliparous 'scrub' goatlings, which had been dry for some months after having been brought into artificial lactation with diethylstilbœstrol during the previous year, were subjected three times weekly to inunction of the udder with 1·0 gm. of 1 per cent diethylstilbœstrol ointment. In one case lactation quickly set in and the yield rose to a maximum of about 570 ml. daily, and then began to decline. It is of interest to note that this peak yield was approximately the same as in the previous artificially induced lactation. At this point, subcutaneous injection on alternate days of 5 ml. of an alkaline extract of ox anterior lobe (10 ml.=2·5 gm. fresh tissue) was begun and the inunctions continued. The milk yield rapidly rose to about 870 ml./day and thereafter declined somewhat despite continuation of the treatment with both œstrogen and pituitary extract. Pituitary treatment therefore increased the peak yield induced by diethylstilbœstrol alone by some 40 per cent.

The other goat, rather surprisingly in view of the fact that similar treatment had induced substantial



MILK YIELDS OF VIRGIN GOATS TREATED WITH DIETHYLSTILBŒSTROL AND ANTERIOR PITUITARY EXTRACT. MILK YIELDS ARE EXPRESSED IN TERMS OF THE AVERAGE DAILY YIELD FOR EACH WEEK.

Diethylstilbœstrol. x——x. Inunction of udder with 1 gm. of a 1 per cent ointment effected three times weekly for 18 weeks. ⊙ – – – – ⊙ Inunction of udder with 1 gm. of a 1 per cent ointment effected three times weekly for 6 weeks, then with 2 gm. of 1 per cent ointment for 4 weeks. Over the remainder of the experiment the original dose was used.

Pituitary extract. 5 ml. (equiv. to 1·25 gm. of fresh ox anterior lobe) given on alternate days from the twelfth week of the experiments onwards.

lactation in the previous year, secreted no more than 20 ml. daily of milk during the period of inunction alone, even when the dose of diethylstilbœstrol was doubled for a time, but addition of anterior pituitary treatment immediately evoked copious milk secretion, the daily yield rapidly rising to nearly 1,700 ml. This amount is comparable with the peak yield expected in a normal lactation period from such an ill-bred animal, and is about 20 per cent above that attained on the previous occasion with diethylstilbœstrol alone. Chemical analyses (fat, non-fatty solids, nitrogen partition, lactose) showed that the milk secreted by both goats was normal.

These experiments, which are being continued, indicate that, in the goat, combined treatment with diethylstilbœstrol and anterior pituitary extract can produce a much more intense lactation than with the former alone. It seems likely that under suitable conditions the artificial lactation so evoked may rival that normally following parturition, which is not surprising in view of the fact that its genesis presumably simulates the mechanism whereby normal lactation is induced.

This work has been aided by a grant from the Agricultural Research Council.

National Institute for Research in Dairying, University of Reading. S. J. FOLLEY.

National Institute for Medical Research, Hampstead, N.W.3. Oct. 8. F. G. YOUNG.

[1] Folley, S. J., Scott Watson, H. M., and Bottomley, A. C., (*Proc. Physiol. Soc.*, March 9, 1940) *J. Physiol.*, **98**, 15P (1940); *J. Dairy Res.*, **12** (in the press).

[2] Folley, S. J., Scott Watson, H. M., and Bottomley, A. C., (*Proc. Physiol. Soc.*, March 26, 1941) *J. Physiol.*, **100** (in the press).

[3] Lewis, A. A., and Turner, C. W., Proc. 33rd Ann. Meeting of Amer. Soc. Animal Production. Nov. 29–Dec. 1, 1940, p. 63.

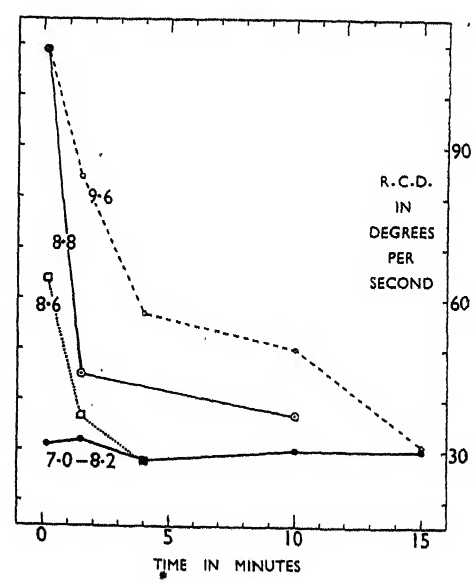
[4] Folley, S. J., and Young, F. G., *J. Endocrinol.*, **2**, 226 (1940).

Klino-kinesis of Paramecium

IT has been shown by Ullyott[1] that the aggregation reaction of the flatworm, *Dendrocœlum lacteum*, in a gradient of light intensities, can be described in terms of the rate of change of direction and the process of sensory adaptation in the eyes. This reaction has since been named 'klino-kinesis'[2]. More recently[3], it was suggested that the well-known 'phobo-taxis' ('avoiding reaction', 'trial-and-error') of Paramecium might be sufficiently similar to be included under the same name. Preliminary experiments by one of us (B.M.W.), which cannot now be continued, provide support for this suggestion. Briefly, the experiments consisted in transferring Paramecium from the culture medium at pH 8·0 to various strengths of acid or alkaline media, and finding the rate of change of direction as soon as possible and at intervals afterwards. It was found that it did depend on the change in pH at first, and that it soon fell to the original basic level; these are the essential features of the klino-kinesis scheme.

The amounts of acetic acid and sodium carbonate required to produce the required changes in the pH of the culture medium were first determined. The Paramecium were pipetted, in a known volume of culture medium, into a watch glass and the appropriate amount of acid or alkali was added; the liquid was rapidly mixed with a pipette and some of it transferred to a suitable slide. The first reading began 6–10 seconds after adding the acid or alkali. A reading consisted in drawing free-hand the tracks of animals taken at random, as seen under the microscope, and marking the tracks at 5-second intervals, with the aid of a metronome; further readings were taken after 1–2, 3–5, 10 and 15 minutes. At least ten tracks were made in each case. The amounts of turning carried out by the organisms were estimated from the drawings, the angles being measured to the nearest 5°.

The accompanying graph shows that on transfer to culture medium made neutral or slightly alkaline (actually pH 7·0, 7·6, 8·0 and 8·2), the rate of change of direction is about 30° per second after 6–10 seconds and remains at that basic level; but on transfer to medium made more alkaline, it is at



pH	Rate of change of direction in degrees per second				
	After 6–10 sec.	1–2 min.	3–5 min.	10 min.	15 min.
4·6	70	41	27	42	23
5·2 and 5·6	42	33	30	30	29
7·0 to 8·2	31	32	28	30	30
8·6	64	37	28	—	—
8·8	109	45	—	37	—
9·6	109	84	57	50	31

first raised and then falls to the basic level. The table gives more extended data and shows a similar effect when Paramecium is transferred to acidified culture medium. On the whole, the greater the change in pH, the greater the rise in rate of change of direction and the longer the time taken to revert to the basic value.

In a further experiment, specimens which had been kept for 15 min. in acidified culture medium (pH 5·6) were transferred back to culture medium at pH 8·0; the rate of change of direction was 58° per sec. after 3 sec. and fell to 31° per sec. after 3 min. This indicates that the rate of change of direction depends on the change in the medium, even when that change is a return to the original culture medium at pH 8·0.

It cannot be said that this work is more than indicative and preliminary. The reactions may not be towards the pH of the medium but may depend on the particular acid or alkali used, and so on. The methods used do not reveal the amount of turning carried out in the first few seconds after transfer to a new pH, when, as the graph suggests, rate of change of direction is likely to be much higher than it is at the time when the earliest reading could be taken. The behaviour during these first few seconds must be most important if the reaction in a gradient is to be effective. The results of the experiments encourage belief in the validity of the description of the behaviour of Paramecium in terms of klinokinesis, and thus help to avoid using terms like 'trial-and-error', which may carry unjustifiable implications.

D. L. GUNN.
B. M. WALSHE.

Department of Zoology,
University of Birmingham.

[1] Ullyott, *J. Exp. Biol.*, 13, 253 (1936).
[2] Gunn, Kennedy and Pielou, NATURE, 140, 1064 (1937).
[3] Fraenkel and Gunn, "The Orientation of Animals" (Oxford, 1940).

Flour and the Growth of Tribolium

IN a recent paper, Fraenkel and Blewett[1] described experiments on the growth of Tribolium on flour. They conclude that for this insect: (1) the addition of vitamin B_1 (aneurin) to patent flour does not in the least alter its nutritional qualities; (2) the nutritional difference between patent (40 per cent extraction) and N.S.R. (73 per cent extraction) flour is almost entirely due to lack of riboflavin in patent flour.

Experiments on Tribolium conducted in these laboratories do not support these conclusions, as a few examples will show. Like Fraenkel and Blewett, the growth period was taken as being the time between the hatching of the larva from the egg and the formation of the pupa.

Temperature, 30°C. Relative humidity, 75 per cent. 20 Larvæ per sample.

		Days in larval period	Number of pupæ
Patent flour (35 per cent extraction)	i	46·8	18
	ii	46·3	18
Patent flour + aneurin (20γ/gm.)	i	41·7	20
	ii	42·4	19
Patent flour + riboflavin (3γ/gm.)	i	29·7	20
	ii	28·5	18
Patent flour + nicotinic acid (3γ/gm.)	i	29·7	20
	ii	28·7	19

It will be seen from this experiment that the addition of B_1 to patent flour does produce a significant increase in growth, while the addition of *either* riboflavin *or* nicotinic acid induces a great improvement, since the larval period is reduced by a third. Moreover, the amount of riboflavin added was only about one fifth of the lowest quantity employed by Fraenkel and Blewett, and thus bears a truer relationship to the actual amounts of riboflavin present in germ (0·2–0·3 mgm. per 100 gm. germ)[2]. The fact that the addition of nicotinic acid to patent flour brings about the same rate of increase as an equal amount of riboflavin disposes of Fraenkel and Blewett's argument that white flour is *specifically* lacking in riboflavin.

For critical experiments on the vitamin requirements of any animal, vitamin-free diets should be employed. In the subsequent experiments with Tribolium, the following vitamin-free diet (here called *A*) was used: vitamin-free casein (15 per cent), fat (3 per cent), Osborn-Mendel salts (4 per cent), starch to 100. It has been known for a long time that the addition of germ or dried brewers' yeast to this vitamin-free diet will supply optimal growth conditions for Tribolium. Further, it has been shown by Street and Palmer[3] that the addition of aneurin alone to such a vitamin-free diet is not sufficient to bring about pupation in this insect, whereas in the presence of aneurin plus autoclaved yeast (in which the aneurin has been destroyed) pupation takes place normally. The following experiments with dried brewers' yeast and autoclaved yeast are relevant in this connexion.

Temperature, 30° C. Relative humidity, 75 per cent. 20 larvæ per sample.

Diet	Days in larval period	Number of pupæ
1. *A*	—	0
	—	0
2. *A* + 10 per cent yeast	18·1	20
	17·5	19
3. *A* + 1 per cent yeast	20·3	18
	21·4	20
4. *A* + 0·625 per cent yeast	24·7	17
	24·8	20
5. *A* + aneurin (20γ/gm.)	—	0
	—	0
6. *A* + 10 per cent autoclaved yeast	—	0
	—	0
7. *A* + 10 per cent autoclaved yeast + aneurin (20γ/gm.)	23·6	18
	23·8	19

In some further experiments to discov[illegible]hich other members of the vitamin B complex are[illegible]uired for the pupation of Tribolium, it was found that neither riboflavin nor nicotinic acid, either alone or in conjunction with aneurin, will bring about pupation. On the other hand, pupation would take place in the presence of aneurin plus a factor present in liver or yeast eluate. The particular sample of liver eluate used was stated to contain [illegible] riboflavi[illegible]t to be rich in vitamin B_6 (adermin). Unfortun[illegible], the amount of adermin present was not known. It is

known, however, that the amount of adermin in whole wheat is at least three times as great as the riboflavin content[4]. Later, by using a pure sample of vitamin B_6 it was confirmed that pupation will take place in the presence of this vitamin plus aneurin. These results are summarized below.

Temperature, 30° C. Relative humidity, 75 per cent. Number of larvæ per sample, 20.

Diet	Days in larval period	Number of pupæ
1–9. A, with riboflavin, nicotinic acid, aneurin riboflavin, liver filtrate factor and liver eluate factor, alone and in various combinations	— —	0 0
10. A + aneurin (20γ/gm.) + liver eluate factor	60·4 59·8	10 14
11. A + B_6 (10γ/gm.)	— —	0 0
12. A + B_6 (10γ/gm.) + aneurin (20γ/gm.)	62·3 64·5	14 17
13. A + B_6 (10γ/gm.) + aneurin (20γ/gm.) + riboflavin (3γ/gm.)...	61·8 63·4	15 16
14. A + B_6 (10γ/gm.) + aneurin (20γ/gm. + riboflavin (3γ/gm.) + nicotinic acid (30γ/gm.)[5]	60·7 60·9	16 17

It should be noted that although pupation does not take place in the presence of vitamin B_6 alone, yet the larvæ remain alive and healthy for as long as 70 days and increase considerably in size, whereas in the riboflavin or nicotinic acid mixtures they die off in about 30 days.

It is evident from these experiments that although aneurin and vitamin B_6 are essential for pupation, there must also be present, even in patent flour, some other growth factor which is as important as any of the known members of the vitamin B complex in promoting rapid growth and pupation.

I am indebted to Mr. A. L. Bacharach for supplying the samples of liver filtrate and eluate, riboflavin, nicotinic acid and vitamin B_6.

E. BARTON-WRIGHT.

Research Association of British Flour Millers, St. Albans.

[1] Fraenkel, G., and Blewett, M., NATURE, 147, 716 (1941).
[2] *Nutr. Abs. and Revs.*, 9, 820 (1940).
[3] Street, H. R., and Palmer, L. S., *Proc. Soc. Exp. Biol. Med.*, 32, 1500 (1935).
[4] Swaminathan, M., NATURE, 145, 780 (1940).
[5] Kodicek, E., *Biochem. J.*, 34, 712 (1940).

Surface Tension and Molecular Dimensions

THE following argument is advanced in support of the hypothesis that the molecules of long-chain compounds tend to stand up like a carpet pile in their own liquid surfaces just as they do on substrates such as water. By the application of the usual thermodynamical reasoning to the following cycl[illegible]) transfer 1 gm. of substance isothermally fro[illegible] liquid to the surface and thereby increase the area by A sq. cm.; (2) carry out a small adiabatic expansion; (3) transfer 1 gm. of substance isothermally from the surface to the liquid at the lower temperature; (4) carry out an equal adiabatic contraction—we obtain the equation

$$\text{[illegible]iency} = \frac{dT}{[illegible]} = -\frac{AdS}{H}\text{; that is, } \frac{H}{T} = -\frac{dS}{dT}A, \quad (1)$$

[illegible]re S is the surface tension.

The surface energy, or total work of transfer, per gram of substance, is

$$SA - T\frac{dS}{dT}A = \left(S - T\frac{dS}{dT}\right)A, \quad . \quad . \quad . \quad . \quad (2)$$

This is usually obtained in the form:

$$\text{Surface energy per sq. cm.} = S - T\frac{dS}{dT},$$

by an argument involving 'stretching the film'. We consider the standard Kelvin method is faulty, because what is called 'stretching the film' is actually a transfer of molecules from the liquid to the surface state. Equation (2) can only apply when the surface is practically complete, that is, the probability of the vapour state can be neglected.

It is well known that, for this region of low vapour pressure, the $S-T$ curves for many liquids are very approximately linear, so that the surface energy per sq. cm. is practically constant. We suggest that this is so because the surface area per gram of substance is changing but slowly, and that it is really the surface energy per gram that is constant. The linear portion of the $S-T$ curve, extrapolated to cut the axis of T, intercepts it at T_c, which is approximately the same as the critical temperature obtained from vapour pressure measurements. This gives the constant surface energy as $-T_c\frac{dS}{dT}A$. Per gram-molecule this constant surface energy is $-T_c\frac{dS}{dT}AM = nRT_c$. The surface area per molecule will then be

$$\frac{AM}{N} = -\frac{nR}{N\,dS/dT} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

We further suggest that the number 'n' in the above equation is the same for all chain-molecular liquids. Substitution of values AM/N, the basal molecular area obtained from X-ray diffraction patterns of aliphatic compounds in the solid state, suggests that $n = 1{\cdot}5$. The constant surface energy is thus equal to the kinetic energy of translation at the critical temperature. Using this value in equation (3), we can find molecular lengths if we assume that the density in the surface state is not very different from that in the liquid state. If l is the length per molecule,

$$l = \frac{1}{\rho_s A} = -\frac{M\,dS/dT}{\frac{3}{2}R\rho_s} \quad . \quad . \quad . \quad . \quad (4)$$

Since l is the molecular thickness associated with the molecular weight M, we see that the surface tension is independent of chainwise association in the surface layer.

The values obtained for a typical series are given below:

Alcohol	Formula	$-\frac{dS}{dT}$	$a \times 10^{16}$ cm^2.	$l \times 10^8$ cm.	Increase per CH_2
Methyl	CH_3OH	0·0875	23·8	2·82	
Ethyl	C_2H_5OH	0·0875	23·8	4·05	$1{\cdot}23 \times 10^{-8}$ cm.
n-propyl	C_3H_7OH	0·0820	25·4	4·88	$0{\cdot}83 \times 10^{-8}$ cm.
n-butyl	C_4H_9OH	0·0840	24·8	6·12	$1{\cdot}24 \times 10^{-8}$ cm.
n-octyl	$C_8H_{17}OH$	0·0820	25·4	10·35	$1{\cdot}06 \times 10^{-8}$ cm.
Miricyl	$C_{30}H_{61}OH$	0·0780	26·6	32·6	$1{\cdot}01 \times 10^{-8}$ cm.

The approximate equality of the values of dS/dT for the above series indicates that the molecular basal area is approximately the same for all the

members. The same is true in each of the aliphatic series studied.

We wish to thank Dr. W. T. Astbury, of Leeds, for encouragement and for advice with regard to the form of this communication.

A. E. RIDLER.
J. H. SMITH.

High Storrs Grammar School,
Sheffield, 11.
Oct. 8.

Poultry as Food Converters

MR. E. E. JONES, in his letter in NATURE of October 18, states that the goose is the only grass-eating bird available for egg production. While the main object of his communication, which is to encourage the breeding of a superior kind of goose, is no doubt of value, he would seem to infer that the hen does not eat grass. It is true that on a confined run with plenty of other food and no supply of fresh young grass the hen does not because there is none, not because she would not if it were available.

On a limited run, the hen willingly eats cabbage leaves for the sake of fresh green-food, and is often made to jump for it for exercise, but with a large area of good grass on which to roam, a hen will not touch cabbage. I used to let out the hens for an hour to forage in the garden, and they used to dive at once into the edges of the borders in the lawn where, among the leaves collected there, they found plenty of 'creepy-crawleys'. But I noticed that they ate with avidity large quantities of the young grass on the edge where it is freshest and greenest, preferring this to the abundance which they had in their own territory. While no doubt the proportion of grass in their diet is not so great as it is with the goose, it is still an important item if they can get it, but not when it is denied to them.

Will geese any more than hens keep on laying if they are not provided with concentrated food, which it is the object of Mr. Jones to save ?

C. V. BOYS.

St. Marybourne,
Andover.
Oct. 24.

A British-American Scientific Reconstruction Expedition

ONE of the points generally agreed upon during the proceedings of the Conference on Science and World Order arranged by the Division for the Social and International Relations of Science of the British Association was that careful scientific planning is essential for post-war relief and reconstruction work ; and Sir Richard Gregory, in his concluding speech, stated that the Council of the British Association will appoint, at an early date, committees to study the problems and make appropriate recommendations. One problem, however, did not receive the attention of the Conference, a problem which in my opinion is of the greatest importance in planning the reconstruction of the smaller European countries.

The small European countries actively involved in the present War have lost a considerable proportion of their scientifically trained youth. A large number of the leading scientific personalities, professors and members of the staffs of the universities, social and administrative workers have been killed. It is the deliberate policy of the Nazis to destroy cultural and scientific centres, and thus to deprive conquered nations of the backbone of future reconstruction. Germany is doing everything to make the revival of the nations as difficult as possible. This is exemplified not only by the murder of the leading minds of each nation and of scientifically trained youth which could replace their masters and continue their work, but also by the destruction or removal of scientific equipment, by burning libraries, pulling down essential buildings, etc.

There can be no doubt that after an armistice has been signed, the smaller countries of Europe will need help from the outside world to re-establish scientific centres. There is no purpose in planning co-operation of scientific bodies on an international scale if such bodies in the various countries are unable to organize their work, or may not even exist, because of the lack of personnel to revive them and to carry out the work.

I know that Britain and the United States will be willing to do their utmost to help, but in order that assistance may be rendered in the most efficient way plans and foundations for it must be laid immediately. I suggest, therefore, that a detailed scheme be drawn up now for a British-American Scientific Reconstruction Expedition to the smaller countries of Europe.

A plan ought to be devised in collaboration with scientific workers from Nazi-dominated countries who have happily managed to escape and are at present continuing their work in hospitable British scientific centres, so that, immediately hostilities come to an end, arrangements might be made to send into each of the liberated countries a unit of scientific workers, which will be able to administer 'scientific first aid' and to establish in the shortest possible time conditions suitable for carrying out scientific work, and where necesary to initiate it. Not only will senior scientific workers be required to take over the lead and direct the work of reconstruction, but also a considerable number of younger workers, with up-to-date knowledge in the different branches of science, will be essential to pave the way for science during the first post-war years, before the huge loss in scientific man-power of these nations is made good again.

The Scientific Reconstruction Expedition will have to be able to provide scientific instruments, to re-equip laboratories, to rebuild essential buildings, to re-stock libraries, and perhaps also to provide the necessary funds. Like the Red Cross in the field of medicine and human welfare, the Scientific Reconstruction Expedition would be a mission of goodwill in the field of science. Its aim would be to help to restore the life of the smaller nations by assisting to re-establish their national centres for scientific work, and by doing so, to serve the cause of science throughout the world.

R. BRAUDE.

Poland :
at the National Institute for
Research in Dairying,
Shinfield,
Near Reading.

RESEARCH STUDIES IN EDUCATION

IN the last few years the U.S. Office of Education has published an annual Bibliography of Research Studies in Education. The most recent volume to hand* reveals activity in the sphere of education which must be without parallel anywhere else in the world. Altogether, for the year 1938–39, it lists 3,569 theses, submitted by research workers in 174 institutions. Taken in the broad view they give one the impression that in the United States the whole field of education is open to inquiry, that policy is in no way bound down by tradition; instead, accepting democratic principles, it is adjusting itself to the continual changes taking place outside school and college. These research studies provide the material for informed opinion, which cannot fail to exert a beneficial influence upon teachers, administrators, parents, and incidentally upon the pupils, too.

Of the papers listed in the Bibliography almost a half are concerned with curriculum studies and with problems met with in the teaching of individual subjects. Some measure of the interest taken in developments in the different subjects, in their American setting, may be gathered from the number of papers devoted to each. There are, for example, 135 papers on physical training and recreation, 115 on scientific subjects, 109 on commercial education, 108 on reading, 103 on mathematics, 84 on music, 69 on home economics, 65 on English, 56 on agriculture, 43 on health education, with only 27 papers devoted to art, 22 to history, 14 to modern languages and 12 to the classics. One gains the impression that formal methods of teaching are yielding place to more varied and more actual lines of approach. Attempts to build up logical unity are being abandoned for methods based upon the pupil's own experience and active co-operation. The conception of education is broadening, not only to fit pupils into suitable occupations in adult life, but also to see that they take their part as useful members of the living community. This emphasis on the social side of education is exerting an influence upon teacher-training, for it is found that teachers who are maladjusted professionally are often maladjusted in other walks of life.

Many other papers deal with the organization of education and administrative problems. Much thought is being given to fitting the school into its proper place, a question which is looked upon more from the personal and communal angle than as a matter of national concern. The same line of thought accounts for many papers devoted to the development and present position of education, treated both historically and on the comparable basis of what is happening in other countries. Given certain types of social and economic setting, and certain standards in pupil and parent requirements, it is clear that American educational institutions are meeting fairly adequately such demands as are made upon them.

As one might expect, the large majority of the papers are almost purely descriptive in nature, or they survey known facts and existing circumstances in the attempt to shed new light upon them. Nevertheless, in spite of their short range and empirical character, suggestive results are obtained, some of which are capable of broad application. One investigation, for example, shows that children are more interested in the text than in the format of the books they read, and another, based upon differing interests, points to separate reading-books for girls and boys. Studies in child vocabulary indicate that many books read in school contain words which lie far beyond the child's own age experience. This point applies with some force to science text-books, and deserves more attention than it has so far received. The way is clear for an accepted vocabulary for school use, expanding as the child-mind develops.

Surveys of pupils' leisure time activities show that there is among girls a desire for more physical activity in place of sedentary occupations. Man craves for physical exertion. The school camp is becoming a definite part of the school programme. A number of surveys indicate that inadequate attention is given to health education, in which application lags behind the pupil's own actual knowledge. A comparison between farmers and future farmers in Pennsylvania revealed little difference in total scientific knowledge. The farmers excelled in biological and health knowledge, the young boys in the exact sciences. The fathers were slightly more superstitious than their sons, and both groups tended to correct misconceptions by direct experience. Almost inevitably, an investigation of pupils' honesty showed that there is a positive correlation between cheating and the importance attached by the teacher to the particular test; and for the pessimists, an experiment in trying to teach secondary school students to resist propaganda showed that the instruction offered was ineffective.

One paper reports that mathematics feature considerably more in the curriculum in Great Britain than in the United States, and that British mathematical teachers are more intensively drilled. The theses on scientific subjects are nearly all concerned with general science, biology and chemistry, with scant attention being devoted to physics in education. There is one paper on astronomy and three on geology. Nearly all these papers are taken up with details of teaching technique and with the comparative study of text-books and syllabus requirements within the framework of existing conditions. Relating the science teaching more directly to the pupil's own experiences has a beneficial effect upon their work. Nevertheless, except for some interest in wild life, soil conservation and consumer requirements, there is little evidence of any attempt to lift science teaching on to a plane which would give it broad contacts with human life and with human thought.

Few inquiries have been directed to nutritional standards in the school population, and while in the United States access to educational facilities is widely available to children of all social grades, almost no studies have been concerned with the relation between education and social opportunity, except for those dealing specifically with the Negroes. Much work has been done on the reliability of intelligence tests and on the psychology of memorizing, but little thought has been given to the relations between intelligence, personal effectiveness and physical well-being, and between intrinsic intelligence and success in later life.

Altogether, it is the long view which seems to be missing. What in Great Britain is beginning to be termed human biology, in which biological knowledge

* Bibliography of Research Studies on Education, 1938–1939. U.S. Office of Education, Bulletin, 1940, No. 5.

is applied to individual development, family and social life, is a subject scarcely touched upon. The psychological problem of the relation between knowledge acquired at school and its application in personal living, and the deeper psychological problem of the relation between the inculcation of cultural standards and their expression in personal conduct, are fields almost untilled.

In the United States, where the impact of science has changed social and cultural standards more extensively than elsewhere, and where the rate of change shows every sign of both increasing and continuing indefinitely, altering in its train the environmental framework of man, insufficient attention has as yet been given to science as an educational force, so that the influences affecting man's destiny might be understood, and in that measure brought under control.

HYPERFREQUENCY ELECTROMAGNETIC WAVES AND THEIR PRACTICAL USE

IN a paper by Dr. Léon Brillouin presented at a meeting of the Franklin Institute held on April 6, 1939, and reprinted in the *Journal* of the Institute of June 1941, the author begins by discussing the meaning attached to the word hyperfrequency. It has commonly been used for frequencies higher than 10^9 c./s. (1000 Mc./s.) which correspond to electromagnetic waves the wave-lengths of which are shorter than 30 cm. Brillouin has studied the behaviour of electromagnetic waves of which the lengths are comprised between approximately 1 cm. and a few decimetres.

At the present time, this region of the electromagnetic spectrum is of great interest in many practical fields. The radio engineer is specially anxious to study wave-lengths of the order of one centimetre or less. Very little is known of this region until we reach wave-lengths of 0·1 mm., which correspond to the extreme infra-red. Emission and absorption spectra have still to be measured, together with optical properties of chemical compounds. Some very remarkable results have already been obtained, such as an absorption spectrum for ammonia and a strong change in the dielectric properties of water. These researches will become still more interesting when wave-lengths of a few millimetres, or fractions of a millimetre, can be produced with sufficient energy. It is to be foreseen that all chemical compounds which have an electric dipole should show a typical variation of their electric properties in this region. These waves should enable us to build up new methods of making investigations on molecular structures.

The physicist is waiting for the gap between radio and optics to be filled up. He is still very anxious to link these two different fields together. Experiments have already been tried with damped waves, but so far precise measurements have only been made with undamped and continuous waves, and precise measurements are what the physicist is anxious to obtain. The problem presents as much interest to the radio engineer as it does to the physicist. For the last twenty years or so the tendency in radio is to push in the direction of measuring even shorter wave-lengths. We do not yet know where the practical limit of measuring short waves precisely will be reached. But it has already been demonstrated that wave-lengths some centimetres long may prove of great value for radio-communication, television, signalling (radio-beacon), obstacle detection, not forgetting the use of dielectric cables. All this is more than sufficient to arouse keen interest and promote very active technical research in engineering and technical industries.

Wave-lengths some decimetres long were first used by Hertz to repeat optical experiments, such as prismatic deflexion or diffraction; and this similarity of short radio-waves to optical waves has been emphasized by a great many experimenters. Optical lenses, mirrors, parabolic reflectors are very effective as soon as they can be built with dimensions of a few wave-lengths. Another and more recently discovered point is the analogy between hyperfrequency radio-waves and acoustics. Since the wave-lengths are of the same order of magnitude in both cases, we may now note the very important use of electrical apparatus curiously similar to acoustical instruments: hollow pipes, like organ pipes; hollow resonators reminiscent of Helmholtz's acoustical resonators, and dielectric cables, which show a marked relationship with pipes as used in acoustics. Hollow tank resonators have been suggested by several physicists, mostly on the basis that they give very slight damping. As commonly expressed by radio engineers, these hollow resonators show very high Q factors; a high Q means that the resonator oscillates freely a great many times before the amplitude of the oscillations is reduced to a small value. There is another aspect of the question which seems worth noticing; this is the possibility of first storing up energy in the resonator, and afterwards radiating this energy.

The question arises: How far can we increase the fields? If air is at atmospheric pressure, its disruptive potential is about 30,000 volts per cm., that is, 100 C.G.S. electrostatic units. This upper limit will never be reached in practice. If one wishes to accumulate electromagnetic energy in a given volume, it can only be done by producing high electrical and magnetic fields inside this volume. Making certain assumptions, Brillouin calculates that the average field attains perhaps 15 E.S. units. This means that it contains 1 joule of energy per cubic metre. For short radio-waves, ordinary inductance capacity circuits cannot be used. The technical practice is to use parallel lines or coaxial lines as resonators. These lines can only be built if the distance between the two parallel wires is small with respect to the wave-length. This can no longer be done with hyperfrequency waves, and we are thus forced to work with tank resonators.

The Laboratoires L.M.T. (laboratories of Le Matériel Téléphonique in Paris) have been very active for a good many years in the field of hyperfrequencies. The researches were conducted by MM. Clavier, Darbord and various co-workers and resulted in radio transmission across the English Channel, using a wave-length of 18 cm. Photographs are given of the apparatus employed. The reflectors

produce a linear beam of very small aperture, directed from the transmitting to the receiving station. The reflectors must be in direct sight. In the cross-Channel communications, for example, one of the stations was at St. Inglevert on the French side, the other at Lympne in England, the distance between being about 50 kilometres. The electro-optical equipments were installed on suitable steel towers at St. Inglevert and Lympne. The results of operation were very good on this link, which represents the shortest wavelength circuit in commercial use. The link was used for two-way teleprinter messages as well as duplex telephony. Atmospherics are never heard on the circuits. No interference whatever is caused either by thunderstorms or motor-cars; the background noise in the receiver exactly resembles normal tube noise.

A very important step was taken when Southworth, Carson, Mead and Schelkunoff, of the Bell Laboratories, first began investigating short-wave propagation along conducting hollow tubes (so-called dielectric cables). Very similar researches were started almost at the same time by Barrow at the Massachusetts Institute of Technology. Brillouin concludes by discussing the theory of dielectric cables for various kinds of cross-sections. These high-frequency oscillations have opened up a new field of research in which are very curious theoretical and technical problems, and good prospects for important practical applications.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

MONDAY, NOVEMBER 10

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 3 p.m.—Mr. Thomas Peacock: "Farming's Great War Effort".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Lieut. A. R. Glen: "Recent Changes in the Spitsbergen Glaciers".

SOCIETY OF CHEMICAL INDUSTRY (under the auspices of the Institute of Chemistry in the General Lecture Theatre of the University of Leeds), at 6.30 p.m.—Dr. Dorothy Jordan Lloyd: "Application of X-Rays to Leather Manufacture".

TUESDAY, NOVEMBER 11

CHADWICK PUBLIC LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Mr. Fredk. R. Hiorns: "Hygiene Technique in Building, or the Economic, Psychological and Health Aspects of Surface Treatment".*

WEDNESDAY, NOVEMBER 12

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. A. J. Amos: "Microbiology and Baking".

THURSDAY, NOVEMBER 13

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Dr. Harold King, F.R.S.: "Chemistry and Pharmacy".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 3.30 p.m.—Dr. W. E. Gye, F.R.S.: "Filterable Tumours" (Imperial Cancer Research Fund Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE MATHEMATICS DEPARTMENT—The Secretary, The Technical College, Sunderland (November 15).

CHIEF ASSISTANT ENGINEER—The Engineer to the Witham and Steeping Rivers Catchment Board, 50 Wide Bargate, Boston, Lincs. (November 17).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, County Technical College, Worksop, Notts. (November 18).

PROFESSOR OF EDUCATION—The Bursar and Deputy Registrar, University College of North Wales, Bangor (November 22).

SENIOR PHYSICS MASTER at the Rutherford College Boys' School, Newcastle-upon-Tyne—The Director of Education, City Education Office, Newcastle-upon-Tyne, 2 (November 29).

ASSISTANT ENGINEER to the Sudan Government Railways—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (endorsed 'Assistant Engineer').

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 13: Analytical Methods in Rubber Chemistry, 4: The Determination of Peroxidic Oxygen. By J. L. Bolland, A. Sundralingam, D. A. Sutton and G. R. Tristram. Pp. 4. (London: British Rubber Producers' Research Association.) [1510

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 13, No. 1, June 1941. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+78. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [1510

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 17: The Comparative Genetics of *Gossypium anomalum* and the Cultivated Asiatic Cottons. By R. A. Silow. Pp. 259-358. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*. [1510

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NATURE

SATURDAY Nov. 15, 1941

SCIENTIFIC METHOD IN ECONOMIC PLANNING

SCIENTIFIC workers, whatever their attitude to planning, will read the article by Prof. F. Hayek on "Planning, Science and Freedom", which appears on p. 580, with respect and some measure of appreciation. Whether or not his point of view is accepted, he has made an important contribution to clear thinking on a difficult and urgent problem. Even those who find his attitude negative and hold that he makes no constructive proposals, may none the less be grateful for his clear indications of some of the dangers that planning holds for science and freedom, if it is not inspired by creative thought and guided by sound and wise judgment.

Prof. Hayek's article appears to be directed particularly against economic planning. He is careful to dissociate himself from any argument about planning in the general sense of a rational design of human institutions, the desirability of which, by implication, he admits. He attacks the central direction of all economic life as against its direction by competition. His support of the competitive or price system is based on the view that a controlled economy is less efficient and that it leads direct to a totalitarian system, despotic control in every sphere of life, the repression of individuality and freedom, with all that is implied for scientific work by such repression.

No scientific worker can fail to recognize that such dangers exist and that under a totalitarian regime, whether in Germany or in Russia, scientific work of one kind or another has been impeded to greater or less degree. Prof. Hayek, however, does not advance convincing reasons as to why a totalitarian system should be the only outcome of even economic planning, and his whole argument loses verisimilitude to-day when he exempts from his attack the conception of rational planning of all human institutions in their mutual relations. It is this conception of planning for freedom that dominates the field to-day, as it inspired the whole conception of the recent Conference on Science and World Order.

The planning of the twentieth century rests its case, as Dr. Lewis L. Lerwin well said at the World Social Economic Congress in 1931, on a philosophical faith in the power of man to promote orderly economic and social change through scientific research and constructive imagination. Even at that time, Dr. Lerwin distinguished clearly between economic planning itself and technical and industrial planning and rationalization. Using the concept and mechanism of social price, economic planning attempts by new methods to co-ordinate and balance production and distribution, and while Dr. Lerwin admits that planning must be a national

function in method as well as in purpose and must possess a measure of Government authority, he sees alternatives to absolute socialist planning and to the partial State socialist planning of the U.S.S.R. in a voluntary business type of planning and a social progressive type of planning.

The ideas implicit in the latter type are in fact reflected in many of the proposals or developments which in the last few years have given a further impulse to the notion of planning, whether in regard, for example, to re-planning and re-building and the location of industry under the Ministry of Works and Buildings, or to those developments proceeding under the Leith-Ross Committee and in other ways for dealing with the disposal of surpluses and for commodity control. The realization of the waste and damage to national resources through uncorrelated individual action and private interests has been forced too vividly on the attention of the nation for it to contemplate a deliberate return to the pre-war chaos when war-time controls are relaxed. The choice to-day is not between planning and not planning, but rather of the type of planning to be adopted, and the purposes to be served. The peril of economic and political chaos after the War is too serious for no attempt to be made now to provide the institutions or policy for averting, or at least minimizing, these dangers for concerted effort.

It is equally clear that, in the post-war society, the price system will not be accepted as by itself a sufficient determinant. This is not because the idea of private property is likely to be rejected or that the ideal of service rather than profit will be a sufficient motive, but because the usual concept of price has no regard to the social effects of competition. It is this limitation that has had such untoward effects in the distressed areas as has been emphasized in one study after another, from the Barlow Commission's report to the various investigations of areas carried out by the University of Liverpool and similar bodies. In the absence of social control and definite planning, the price system and unrestricted competition will assuredly have equally or even more disastrous results for the community as a whole after the War.

A further tendency, which is also ignored by Prof. Hayek, is the new conception of the function of government as the nation's instrument for planning, and for action to safeguard and develop the collective inheritance and the social and economic welfare of the nation in peace and war. The old conception of government as a regulatory, policing and taxing mechanism is recognized as inadequate. The main weaknesses of our executive machinery of government to-day admittedly follow from failure definitely to adopt such a positive conception of government in all those spheres where individuals or private associations cannot achieve equally effective results.

If, however, the Spencerian concept that there is something inherently wicked and dangerous in government, and that the least government is the best government, should be rejected decisively to-day, there is in it, as in Prof. Hayek's views, a warning we disregard at our peril. As Cobban reminds us in "The Crisis of Civilization", while free association may be a good thing, government and organization can never be more than a necessary evil. The power of government is justifiable in accordance with its utility or the degree in which it promotes the rights of the individual. All absolute sovereignty is a usurpation.

Government, Cobban maintains, is a contrivance instituted by human wisdom for the better attainment of those ends which are laid down by the ethical intuitions of mankind, and which take the form of the natural rights of the individual of self-preservation, free association, the possibility of happiness and a certain field of free activity. The end of government should be to promote the realization of the rights of its subjects. Directly government ceases to be the instrument and in the personified State becomes the end in itself, individuality and freedom are imperilled or, as in the totalitarian State, destroyed.

At a time of flux and reconstruction, when men are seeking to mould instruments of government more effectively on an international as well as on a national scale to their social purposes, this warning, so firmly underlined by the events of the past two decades, needs to be kept clearly in mind. It is significant, moreover, that an essentially similar concept of economic planning inspired its leaders fully a decade ago, as is illustrated not only by Lerwin's paper already quoted but also by that of Mary Follett on "Individualism in a Planned Society" (recently reprinted in "Dynamic Administration"). Planning is to them an instrument for collective self-control, which can and should give scope to individual initiative by showing it the way to combine effectively with other individual initiatives. Individualism is regarded not as something apart but as something contributing to the whole, and freedom is not freedom from relation but freedom through organized relation.

The dynamic conception of planning and government as a collective instrument for co-ordination, based not on coercion from above, but on conference and agreement in accordance with ascertained facts and the changing needs of society, is fundamentally different from the conception attacked by Prof. Hayek and also that which finds concrete expression in the totalitarian regimes to-day. Planning, as Mannheim points out, does not mean rule by arbitrary forces over the living body of

society, nor the dictatorial attempt to supplant creative activity. It means, on the contrary, a conscious attack on the sources of maladjustment in the social order on the basis of a thorough knowledge of the whole mechanism of society and the way in which it works. It is not the treatment of symptoms but an attack on the strategic points.

Prof. Hayek's views must not be dismissed as entirely irrelevant because the type of planning which he attacks does not meet the criteria of such thinkers as Lerwin, Follett or Mannheim. They should rather be taken as endorsing Mannheim's contention that we should deliberately plan for freedom, and as a reminder of the dangers of partial attempts taking account of economic or political factors alone. Moreover, as Mannheim points out, we have still to elaborate much of the technique of social change. We have indeed to learn even from the totalitarian States how to use planned persuasion, not for stirring up strife, but for encouraging behaviour on which all our hopes of peace, co-operation and understanding depend.

The co-ordination of activities involved in this conception of planning is not incompatible with or inimical to freedom, provided these ideals are kept in mind. The elaboration of the necessary technique and social controls requires objective scientific research as well as the retention of such established democratic principles as equality of opportunity, the selection of the fittest and respect for human personality. It is a challenge to sociology and to psychology as much as to economics, and offers, as Mannheim points out, a real chance for sociology to make a creative contribution to the reconstruction of our society. While it may well be important, as both Cobban and Mannheim urge, to diminish the number of purely political issues and dissociate the national and international organs of welfare, health, education and economic co-operation from political and military control, a new experimental attitude in social, including economic, affairs holds the best promise of creative thought and constructive proposals.

It is the magnitude of this challenge to thought that captures the imagination to-day. Only by achieving on a larger scale and in new ways the co-ordination of his activities can man hope to retain real freedom. The new forms of organization must be evolved to serve clearly ascertained needs, and be recognized as instruments and not as ends in themselves. They must be so developed as to enlist the willing co-operation of the individuals and groups whose needs they are to serve.

Undoubtedly the dangers to which Prof. Hayek refers exist, but if humanity is deterred by dangers it is already doomed. Unless society is able to evolve further controls and organized relations while maintaining the individual capacity for adjustment, hope of a new order is a delusion. Separation and local autonomy can no longer be allowed to have the last word, but unless the democratic constitution of a planned society can avoid the bureaucratic absolutism, which is the main target of Prof. Hayek's attack, disaster is equally certain. The transfer of democratic, parliamentary control to a planned or co-ordinated society is a difficult and intricate task, and destruction of that control in the effort to establish a planned society means disaster. None the less, mankind must continue to run risks and to press forward. The study of history does not warrant pessimism as to the ability of society to throw up the men for the great occasions, or to evolve the institutions to serve its increasing and changing needs, so long as the fountain heads of knowledge and creative thought flow free and untainted.

AGRICULTURAL EDUCATION

The appointment by the Minister of Agriculture of a Committee to review the position of agricultural education (see Nature of August 9, p. 161) will be welcome to many who have long regarded a national committee or commission on agricultural education as being needed.

Agricultural education in Great Britain under Government ægis dates from 1888 and the passing of the Technical Instruction Act. In that year an agricultural committee of the Privy Council was formed, and given £5,000 with which to assist agricultural institutions. Agricultural education had, however, been operative in some measure before that, and its development can most usefully be considered from about 1840. At that time the basic process of all farming and all life—the process of photosynthesis—was first universally recognized, the Royal Agricultural Society came into being with its motto, "Practice with Science", and the first Rothamsted experiments were about to begin. During the century that has followed, the conspectus of the broad problem of agricultural education has altered in one very important respect. A hundred years ago there was much skilled craftsmanship in British farming and the limiting factor was lack of scientific knowledge. Since that time the development of scientific knowledge and the output of research has out-

stripped the development of the education and scientific training of the craftsman, and the limiting factor now is the trained ability of the husbandman to use the vast amount of knowledge and understanding of his materials and processes that have accrued. The major problem now is not more knowledge, but more personal education. It is therefore gratifying to note that the Committee appointed by the Minister is to consider the work of primary and secondary schools, and the subsequent personal training of the diverse categories of agriculturists.

To those engaged in programmes of agricultural education the foundations laid in the work of schools and in immediate post-school work is obviously of primary importance. Not that agricultural educationists would necessarily advocate vocational agricultural training in schools—they have, in fact, advocated a continuation of some general education in post-school work. What is commonly called rural science can be incorporated in a scheme of general education without being agriculturally vocational. The fact that scientific principles are illustrated by processes of farm and countryside gives no improper bias. Indeed, it may be regarded as a definite disadvantage to urban schools that such illustrations of scientific principles are not easily available to them, since it is a reasonable part of the educational demands of everyone, whatever his future occupation, to be given some understanding of the scientific basis of life.

The future agriculturist must get experience of practical farm work, normally after leaving school, and the continuity of his education in the year or years of apprenticeship, involving the establishment of appropriate day or evening classes, has been the most difficult part of the whole scheme of agricultural education. The service of elementary technical education to the farming initiate is far behind its service to apprentices in urban industries. Transport difficulties in bringing a highly dispersed rural people to a teaching centre, combined with inadequate public opinion on agricultural education, made the task impossible in the early days of technical education. The small but definite measure of success in recent years among the junior post-school agriculturists is probably due more to the work of young farmers' clubs than any other single factor. This suggests that other and less formal methods than the orthodox technical classes may be necessary to establish the continuity of the education of young agriculturists from the school-leaving age, but orderly and systematic study must necessarily be the main activity, and the discipline of education must remain in agricultural education as in all education. Alternatively, compulsory continuation classes as were contemplated in the Education Act of 1918 may have to be considered. Certainly, continuity at this critical stage in agricultural education is a major problem, and once such continuity can be established many more agriculturists will come on to whole-time courses in farm institute, college or university.

The present arrangements of agricultural education, in addition to providing diverse courses of systematic instruction, also provide the farmer with free facilities for obtaining technical advice on his many problems. There seems, however, to be scope and need for the co-ordination of these facilities. Every county has its agricultural and horticultural staff, who advise on general problems of husbandry, and each of twelve groups of counties—the advisory provinces—into which England and Wales is divided for the purpose, has a specialist staff with an agricultural chemist, bacteriologist, economist, entomologist, mycologist and veterinary officer at the service of the agricultural and horticultural community. There is, however, no official connexion (except in one province) between the county and provincial services, and that is a matter that seems to require attention. It is difficult to see that advisory work can attain its maximum efficiency if those who advise on general husbandry have no administrative connexion with those who advise on special problems of infertility, disease, and so forth. A diseased turnip may be a complex problem to the farmer, but it remains an indivisible problem while those who advise the farmer on the growing of turnips and those who investigate and advise on the disease are in independent services.

Besides the need for co-ordination within the whole advisory services, the association of advisory work with the teaching function of the agricultural educationist is a matter of some moment. The creation of universal public opinion in the farming community in favour of comprehensive courses of agricultural studies has still to be achieved, and there is no doubt that those who successfully advise farmers on technical problems are, over and above their services in solving the immediate problem of the day, doing much to develop a realization of the significance of agricultural education. The identity or intimate association of those who advise farmers and those who teach their sons and daughters in the agricultural classroom is very much needed for some time to come. This association of advisory and teaching function does exist in large measure, but its significance and importance need to be very clearly kept in mind.

Whether or not it comes within the terms of reference of the Committee appointed by the Minister, the agricultural education of the non-

agriculturist is a problem of great national importance. We live in days in which a realization of the basic significance of farming to all people is forced upon us. We realize to-day, as never before since the coming of the industrial age, that farming is the basis, not merely of all the material necessities, but also of all the material amenities of life, and indeed, that it alone among the industries provides the token whereby all men in all ages and in all lands express their mutual goodwill, their loyalties, and all that discriminates human life from animal existence. There should, therefore, be a place in the education of everyone for the development of an appreciation of the farming industry, for acquiring knowledge and understanding of the manifold aspects of the farmer's life. The life and problems of the farming community are still fundamentally the life and problems of all people. The modern industrialist has not left farming as if it did not matter to him : he has delegated it to those who still work on the land, and it should not be too much to ask that all boys and girls be given instruction in the significant position of farming, and that their education will enable them, whatever their own calling, to cultivate an informed opinion about agriculture and its problems.

MODERN PHYSICAL CHEMISTRY

Text-Book of Physical Chemistry
By Dr. Samuel Glasstone. Pp. xiii+1289. (London: Macmillan and Co., Ltd., 1940.) 42s. net.

PHYSICAL chemistry is a somewhat vague but useful term which serves to indicate those parts of chemistry and physics in which the two sciences overlap. There are few subjects in which greater and more rapid advances have been made in the last thirty years: the development of atomic and molecular theory has introduced a host of new topics, and the older parts of the subject have been much clarified and extended, particularly in the treatment of thermodynamics, the theory of solutions, and electro-chemistry. There are in existence a number of monographs dealing with the newer topics, and Dr. Glasstone's two volumes of "Recent Advances" and his "Electrochemistry of Solutions" have been very helpful to chemists in approaching some parts of the subject. It has, however, been evident for some time that a book was needed which would weld the old and the new together into a consistent and comprehensive whole. This gigantic task has now been completed by Dr. Glasstone in the volume under review ; it has been carried out with the competence and clarity which characterize his earlier writings.

The book opens with chapters on atomic structure and radioactivity which are largely physical in character, and which introduce the quantum theory and the fundamentals of wave-mechanics. This is followed by an introduction to thermodynamics, using the Gibbs analytical method and the standard symbols which are now almost universally adopted for the more important thermodynamical functions. Next comes a group of chapters which treat logically a number of new and old topics under the headings of the gaseous state, the solid state, change of state, and the liquid state. The chapter on physical properties and chemical constitution is also a refreshing blend of old and new, and includes discussions of dipole moments, molecular spectra, and magnetism. The chapter on dilute solutions which follows embodies *inter alia* a clear statement of the three definitions of activity coefficient which are to be found in the literature. Phase equilibria are next discussed in a long chapter ; this is largely classical in character, and includes a treatment of three-component systems. The discussion of chemical equilibria which follows embodies an account of statistical methods of calculating entropy changes and a discussion of the third law of thermodynamics. Electrochemistry and chemical kinetics are the next topics to be considered; the chapter on chemical kinetics includes an account of the Eyring-Polanyi theory of the activated complex and a discussion of modern views on homogeneous and heterogeneous catalysis. The final chapter, on surface phenomena, completes a volume of more than 1200 pages.

The treatment in general is a judicious mingling of deduction and description. Clear and adequate accounts of experimental methods and numerous diagrams and tables of data illustrate and enrich the theoretical discussions. The more elementary theory is lucidly set out, but the author does not hesitate to say "it can be shown that" when approaching the more abstruse parts of the subject. This, in the reviewer's opinion, is the proper method to employ in a book of this character ; those who wish to delve more deeply into chemical physics rather than physical chemistry will find adequate guidance in the bibliographies which are appended to each chapter.

In his preface Dr. Glasstone modestly states that his aim is "to take a student with a very elementary knowledge of the subject . . . and to lead him by

easy stages and with the simplest mathematical methods to such an understanding of physical chemistry as will permit him to appreciate the more advanced treatises". This aim is fully achieved, and the new "Glasstone" will soon become well known to honours students in chemistry. It should, however, appeal to a wider public, for there are many chemists outside the universities who will welcome an opportunity of making themselves acquainted with the newer work and its relationship to the old.

S. SUGDEN.

DECREASE OF WILDFOWL THROUGHOUT THE WORLD

International Wildfowl Inquiry
Vol. 1: Factors affecting the General Status of Wild Geese and Wild Duck. Pp. x+123. (Cambridge: At the University Press, 1941.) 8s. 6d. net.

THE disquieting fact has to be faced that the world's stock of wild geese and wild duck is steadily decreasing. To obtain accurate information on this decrease, and to seek some method of checking it, the International Committee for Bird Preservation recently carried out an exhaustive inquiry, the results of which are recorded in the volume under notice.

The destruction of bird life has so often in the past been allowed to continue until some rare species has been exterminated—witness the fate of the sea eagle, osprey and goshawk in Scotland—that it is good to know that some at least of European countries are alive to the potential danger in this decrease of their stock of geese and duck. Sweden, for example (p. 4), has afforded protection throughout the year for five years to all wildfowl in the large province of Jamtland. Contrast this with the state of affairs in Holland (p. 4) where it is estimated that a million wild duck are taken annually in decoys. It is satisfactory to know that few duck decoys are working in Britain. At one of these decoys—Orielton in Pembrokeshire—the duck are not killed, but after being caught and ringed are released. In the year 1935, 1,350 duck were caught and ringed here, and interesting light on their migrations has been shed. It is stated that in Eire and in Denmark duck decoys are illegal, but one wonders what the result of the present War will be as regards the praiseworthy efforts of European nations to conserve their stock of birds. Will Denmark continue such protection, and will Sweden continue to keep the great province of Jamtland a sanctuary? One fears that in the present bitter warfare, birds everywhere are bound to suffer.

This book contains interesting information on the destruction of the eggs of duck and geese in the High North. Captain J. H. MacNeile (p. 23) describes the raids made by Norwegian sealing sloops on the eggs of the eiderduck, which nest in large colonies in Spitsbergen. On the low islands off the Spitsbergen coast brent geese nest in the eider colonies, and the egg hunters make no distinction between the eggs of geese and eiders. Captain MacNeile mentions that in 1935, in early July, hundreds of eggs of eiders and brent geese were taken on one island group alone. The eggs were then hard set and, it might have been thought, useless as food. Captain MacNeile writes:

"How long can the brent geese survive such treatment? It seemed more than doubtful whether one single gosling could have been reared that year on any of the Liefde Bay islands, the principal stronghold of the species in northern Spitsbergen."

In Iceland the raven sucks great numbers of duck eggs. Major W. M. Congreve writes (p. 15):

"Freme was responsible for shooting over fifty ravens on their morning and evening flights to Myvatn, from their distant mountain breeding homes. On the evening flight they were gorged with egg, and it was running from their beaks. Now one can say that this has always gone on. I suppose it has, but what has not gone on until, say, 50 years ago, is the invention of the breech-loading gun, with the everlasting shooting by every Tom, Dick and Harry all over Europe and North Africa."

Chapter 3 of the book deals with another possible cause for the diminution of wildfowl in Britain—the undoubted decrease of the wigeon grass (Zostera) during the past fifteen years. This decrease was specially noticeable in the years 1931 and 1932.

Chapter 7 gives many interesting results of wildfowl ringing. The earliest ringing of duck was by H. C. C. Mortensen in Denmark, who published reports on the teal (in 1908) and on the pintail (1914). Since then, duck have been ringed in large numbers in Iceland, Holland, Germany, Sweden, Finland, and Russia. An unusually interesting ringing record is (p. 98) of a young wigeon ringed in Kinross, and recovered far to the north-west, in Iceland, during its first winter.

INFLUENCE OF WAR UPON SURGERY*

By V. Zachary Cope

SURGERY or chirurgery is the handicraft of healing. It has always been an art, but only during the past hundred years has it become a science. In pre-historic and early historic times the craft must have been almost exclusively exercised upon the victims of inter-tribal war. The earliest crude knowledge of anatomy may have come from skulls cleft by the battle-axe, or chests or abdomens ripped open by spear or sword; and in like manner from the time of earliest combat primitive man must have learned various ways of dressing wounds, extracting arrows or spear-heads from wounds, or applying some form of crude splint to a broken limb. By the time of Hippocrates various methods of practical value had been learnt by experience and were generally taught, but for more than two thousand years little definite advance was made in the art of surgery. Garrison states that through even the sixteenth and seventeenth centuries surgical instruction was so poor that all authorities agreed that war was the only field in which surgery could be learned. The knowledge thus gained was crude, ill co-ordinated, and only advanced by the rough method of trial and error.

Scientific surgery was not possible until there was a knowledge of anatomy, physiology and pathology, and no great extension of surgery was possible before the discovery of anæsthesia. From the time of Hippocrates until Vesalius published his monumental work on anatomy, surgery made few advances. The foundation of physiology, made possible by Harvey's discovery of the circulation of the blood, brought little immediate change apart from the interesting but abortive attempts at blood transfusion by Wren and Lower. Right up to the nineteenth century there were few changes in the methods of treating wounds, apart from those necessitated by the type of missile used. When bullets were round and propelled with only low velocity they did less damage and were often allowed to remain in the body, but when the velocity became higher more damage was done and surgeons such as Larrey used to open up (débrider) the wound and if possible remove the bullet. The usual course of wounds of the limbs was, however, so serious that many surgeons used to recommend primary amputation, and as Garrison remarks, this was often done with reckless profusion by the half-instructed surgeons of the time. The middle of the nineteenth century saw light dawn upon this dark scene, and some of the light was reflected from the battlefield.

In 1846 ether was first used as an anæsthetic, and in 1847 Simpson discovered the value of chloroform for the same purpose. In the next year, 1848, occurred the civil disturbances in Paris and there were many wounded. The value of chloroform was immediately confirmed by Roux, who stated that he had employed it in all his operations with "very marked advantage and without the slightest inconvenience". Thus was shown for the first time how warfare may provide a favourable opportunity for trying out a new scientific remedy. Soon after this the relation of microbes to suppuration was shown by Pasteur, and in 1867 Lister demonstrated how the intelligent use of antiseptics could prevent suppuration in wounds. Though Lister's work was not everywhere received with an open mind, war provided the first great trial of the method. In the Franco-Prussian War of 1870–1871 the German surgeons were very ready to try any method which might give relief to the wounded, and many of them treated the wounds with antiseptics, particularly carbolic acid. But the strength of the solution used was not constant, the methods of using it in different hospitals were various, and the results so conflicting that, though its use became general before the end of the War, the conclusions as to its merit gained no general acceptance. Indeed, in the German history of that War the conclusion is reached "the campaign of 1870–1871 belongs to the pre-antiseptic era". Yet the account given in the history makes it plain that by this War the use of carbolic acid as an antiseptic for general use in operating became widely known among the rising German surgeons.

Though now largely replaced by the aseptic method, there is no doubt that the antiseptic method opened the way for the rapid and great advances which took place in general surgery during the latter half of the nineteenth century. By the beginning of this century surgery had advanced to such an extent that an almost complacent mood came over many who thought that it had attained the limit of its possibilities. To any who thought like this the last thirty years must have caused a rude awakening, for the titanic struggles of the nations—the War of 1914–18, the Spanish Civil War, and the present War—have shown the great limitations of surgery, and at the

* Substance of the Chadwick Public Lecture delivered on October 7.

same time have provided the most valuable opportunities for research.

It is true that little of surgical value came to us from the Boer War—in fact some of the deductions made from that war have been proved to be misleading. The chief result of value was the discovery of the value of inoculation against typhoid fever—a triumph with which the name of Almroth Wright will always be associated.

SURGERY IN THE WAR OF 1914-18

The war of 1914–1918 had a very great influence on surgery in all its branches, and it will be necessary to limit ourselves to some of the most striking advances either initiated or rapidly developed during the course of that War.

It has been well said that "in former wars tetanus was a calamity to be recorded and deplored ; the war of 1914–1918 has shown that it is one which can largely be prevented". At the beginning of that War the incidence of tetanus was high, but when once prophylaxis was introduced the number of cases greatly diminished and remained so during the remainder of the War.

The War of 1914–18 helped largely to make of blood-transfusion an immediately available life-saving measure. So far as can be ascertained it was not until the seventeenth century that the transferring of blood to man, either from an animal or from another man, was considered a practicable proposition. But in spite of the many investigators who experimented with blood-transfusion, there were two great obstacles to the general adoption of the method ; one was the clotting of the blood, the other the incompatability of one blood with another, leading to serious or fatal consequences. In the first decade of this century Landsteiner detected the agglutinins in blood, and Jansky and Moss were thereafter able to classify bloods into four groups and to say which were compatible. Just before the War of 1914–18 the method of preventing clotting by using paraffin-coated tubes was discovered, and actually in 1914 several observers noted that sodium citrate when added to blood prevented its coagulation and caused no harm when injected intravenously. It was after the War had already begun that the first transfusion with citrated blood was made by Agnote in Buenos Aires. There was a delay of two years before the great value of transfusion was realized by the contending armies, but when the American surgeons came across to Europe transfusion was rapidly developed and soon became a recognized measure for saving life. Banks of stored blood are available during the present War for the immediate treatment of shocked or exsanguinated patients, and a further advance has been the use of stored serum or plasma. There have indeed been some who say that there is at present too free a use of this method.

The treatment of wounds underwent great developments during the course of the War of 1914–18. At the beginning many surgeons had a blind faith in the efficacy of antiseptics to prevent or stop sepsis in a wound—a faith which they would scarcely have entertained if they had carefully studied the original writings of Lister. This simple faith was shattered by the work of Wright, Fleming and others, who showed that the antiseptics commonly used, for example, carbolic acid and perchloride of mercury, did more damage to the tissues than to the microbes hidden within them. This led to the use of other antiseptics such as flavine and the hypochlorites, which were more efficacious and did little damage to the tissues. Good results were also claimed for a mixture of bismuth, iodoform and paraffin (BIPP), using a technique introduced by Rutherford Morison. (Readers of Lister's papers will recall with interest that iodoform was the only antiseptic substance that he ever recommended to be introduced into the interior of a wound for its antiseptic effect.) But in order to apply any antiseptic the wound had to be opened up (débridement), and when it was opened up the difficulty of reaching all the damaged parts became evident. So by logical necessity surgeons were brought to see that the best method of avoiding septic wounds was thoroughly to excise the damaged tissues along the edges of the wound, and this ultimately became the routine treatment whenever possible. This excision of damaged tissues (wrongly called débridement) became standard treatment and constituted a wonderful advance in surgical technique. (It is only fair to state that this method had been advocated in the time of the Napoleonic wars by Desault and by Larrey, but they considered that it was only applicable to wounds of the soft parts of the face.)

During the War of 1914–18, thoracic surgery underwent considerable modifications and improvements, which have continued progressively to the present time. The free opening of the thorax, which before that War was a dreaded procedure, is now a daily occurrence.

A branch of surgery which may almost be said to have owed its origin to the War of 1914–18 is that of plastic work. In previous wars gunshot wounds had usually or frequently been made by bullets discharged from a distance, but in the terrible bombardments and close fighting of that War the character of the wounds by shells and bombs became more mutilating. Moreover, in trench warfare and with the wearing of metal

helmets the face was the only part left exposed and was therefore very frequently injured. Such injuries, if the patient survived and the wounds healed, produced terrible caricatures of the human face, and such revolting sights stimulated surgeons to devise methods of repair which should, so far as possible, restore parts to their original appearance. Thus arose the modern art of plastic surgery, in which patience, skill and ingenuity are more needed than in any other branch of surgery. It would take me too long to tell of the marvellous and ingenious turns of technique called into play in this art, how skin is made to travel caterpillar fashion from one part of the body to another, how noses are made from skin borrowed from one part and bone or cartilage taken from another area of the body, how large gaps in the jaw are made good by bone transferred from another bone and grafted on to the remnants of the broken jaw-bone, and many other marvels which are now of daily occurrence.

At the beginning of the War of 1914–18 gunshot injuries of joints were usually treated by incision into the joint, irrigation by antiseptic solutions and drainage by rubber tubes inserted into the cavity of the joint. As the War proceeded, however, it was found that to put a drain into a joint was bad technique, that incision of the infected parts of the wound and removal of foreign bodies with closure or almost complete closure of the joint-cavity led to much better results. After three years of war the improvement was so great that more than four-fifths of joint-wounds were healing by first intention without suppuration, and the amputation-rate at the base hospitals was down to 7 per cent. This was indeed a notable surgical advance directly due to the War.

The loss of a limb is not uncommon in peacetime, but in war it is a very frequent occurrence and it would not be surprising if the great experience of war-time should lead to improvements in the technique of amputation. As a matter of fact during the War of 1914–18 the terrible injuries and the frequent occurrence of gas gangrene frequently made formal amputation inadvisable, so that little technical advance was made in that direction. Ingenious advances were, however, made in the prosthetic apparatus to replace those limbs which were removed, for as the late Mr. Elmslie remarked, "progress in the design and manufacture of artificial limbs has usually occurred as a direct result of great wars".

Though the War of 1914–18 advanced surgery it did not greatly help surgical education. War surgery is very different from civil surgery. In that War, by force of circumstances or by the absence of proper grading, many men of little experience were compelled to do much operating. After the War it was soon evident that such operative experience did not constitute a full or adequate surgical training to cope with the great variety of civilian surgical work. In the present War a much better system has been used for choosing and grading surgeons for responsible work, and the benefit of this has already been observed.

SURGERY IN THE SPANISH CIVIL WAR

The statement that war provides the opportunity of trying out any new method of treatment needs to be qualified by the remark that the opportunity furnished is not always seized. During the Spanish Civil War, however, we had an example of man and opportunity meeting at the appropriate time. I have mentioned that in the War of 1914–18 excision of contaminated wounds proved the best treatment, but with very extensive wounds complicated by fractures and injury to joints, suppuration often could not be prevented, and the consequent frequent after-dressing, either by Carrell-Dakin technique or other means, proved very tedious and prolonged. Similar prolonged and inconvenient treatment had been necessary at one time in those cases of inflammation of bone in which the bone had been widely opened to let out the pus. Twenty years ago, Winnett-Orr proposed that it would be a better proceeding to give complete rest to the part by immobilizing it in plaster of Paris casing and letting the wound heal underneath the plaster. Though, *a priori*, this appeared a dirty and unsurgical method, yet it proved an unqualified success and saved much time and trouble to the surgeon and much discomfort and pain to the patient. It is quite possible that this method may have been applied to gunshot wounds of the limbs before the Spanish War—in fact a similar method is stated to have been used by some surgeons in the last century—but there is no manner of doubt that the credit for making this technique applicable to severe gunshot wounds of the limbs attended by fractures mainly belongs to Trueta.

Trueta practised excision of the damaged tissues of the wound and immediate encasement of the affected limb in plaster of Paris which, unless some complication became evident, was left on for five or six weeks before being changed. It was found that severe infection seldom ensued, that what infection was present usually subsided within a few days, that virulent streptococci which were often present at the beginning gradually disappeared, and the wound took on a healthy appearance so that when the plaster was removed it revealed a granulating surface and a uniting or united fracture. This simple method, which perhaps largely depends upon the perfect rest to the part,

has proved efficient in this present War and must be accounted one of the most remarkable advances in wound treatment of late years.

SURGERY IN THE PRESENT WAR

The present War has been raging for more than two years. Realizing the need and opportunities for research on certain problems the authorities have already arranged for special research units, and some useful information has resulted.

The bugbear of the surgeon is the streptococcus, deadly to human beings, often persistent and latent in wounds and sinuses and difficult to dislodge. A few years ago mankind was blessed by the discovery of a drug which, given internally, was able to diminish and often destroy the streptococcus wherever it might be in the body, except on the surface of wounds. Recently Colebrook has found that this drug, sulphonilamide, when put on to the surface of an infected wound, has a direct inhibitory or destructive effect on the streptococcus, and this discovery is full of promise.

The other discovery deals with the effect of blast upon the human body. Everyone is now aware of the terrible effect of the blast due to the bursting of a large high-explosive bomb. A person may be killed by this blast without any external mark of injury being apparent. How this lethal effect is produced and how it may be prevented has been the subject of a research by Zuckerman and by others who have already obtained results which are full of promise for the successful prevention of injury from the terrible injuring force.

INDIRECT RESULTS OF WAR UPON SURGERY

War affects a nation otherwise than by direct physical damage. Food-supplies are often diminished to a level which is incompatible with health, and various diseases may find a chance to flourish which could not gain a footing in normal times. This was shown by the statistics of surgical diseases as they occurred in one of the large Russian hospitals during the time of the War of 1914–18 and the subsequent revolution. The whole social framework of the country was broken for a time and disease of every kind was rife. Starvation and undernourishment were prevalent. In these circumstances it was noteworthy that the number of cases of appendicitis and cholecystitis diminished almost to vanishing point, while ulceration of the stomach and duodenum increased altogether out of proportion. It is certainly significant that the most common surgical disease of the abdomen should almost disappear when war compelled drastic reduction in the diet scheme. It may well be that many other factors were concerned in this reduction, but on the face of it there may be some indication as to the pathology of appendicitis.

Every wise practitioner is taught by time and experience that to prevent is better than to cure, or to speak paradoxically, prophylaxis is the better part of treatment. The best cure of wounds is to prevent them. So we may hope that future generations may profit by the terrible experiences of the present time and there may develop the perfect prophylaxis of the war disease—that for which all of us are longing—peace.

PLANNING, SCIENCE AND FREEDOM

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THE last ten years have witnessed in Great Britain a strong revival of a movement that for at least three generations has been a decisive force in the formation of opinion and the trend of social affairs in Europe: the movement for 'economic planning'. As in other countries—first in France and then particularly in Germany—this movement has been strongly supported and even led by men of science and engineers. It has now so far succeeded in capturing public opinion that what little opposition there is comes almost solely from a small group of economists. To these economists this movement seems not only to propose unsuitable means for the ends at which it aims; it also appears to them as the main cause of that destruction of individual liberty and spiritual freedom which is the great threat of our age. If these economists are right, a large number of men of science are unwittingly striving to create a state of affairs which they have most reason to fear. It is the purpose of the following sketch to outline the argument on which that view is based.

Any brief discussion of 'economic planning' is handicapped by the necessity of first explaining what precisely is meant by 'planning'. If the term were taken in its most general sense of a rational design of human institutions, there could be no room for argument about its desirability. But

although the popularity of 'planning' is at least partly due to this wider connotation of the word, it is now generally used in a narrower, more specific sense. It describes one only among the different principles which might be deliberately chosen for the organization of economic life: that of central direction of all economic effort as against its direction by competition. Planning, in other words, now means that not only the kind of economic system which we want to adopt should be rationally chosen, but that we should chose one that rests on 'conscious' or central control of all economic activity. It is evidently in this sense that, for example, Professor P. M. S. Blackett uses the term when he explains that "the object of planning is largely to overcome the results of competition"[1]. This narrow use of the term is of course meant to suggest that only this kind of economic organization is rational, and that therefore it alone deserves to be called planning. It is this contention which economists deny.

The full argument which leads to the conclusion that planning in the sense of central direction is in fact an inefficient system cannot be reproduced in a few sentences. But the gist of it is simple enough. It is that the competitive or price system makes possible the utilization of an amount of concrete knowledge which could never be achieved or approached without it. It is true, of course, that the director of any centrally planned system is likely to know more than any single entrepreneur under competition. But the former could not possibly use in his single plan all the combined knowledge of all the individual entrepreneurs that is used under competition. The knowledge which is significant here is not so much knowledge of general laws, but knowledge of particular facts and the ever-changing circumstances of the moment—a knowledge which only the man on the spot can possess. The problem of the maximum utilization of knowledge can therefore be solved only by some system which decentralizes the decisions. There is no possibility of a division between the general outline of the plan and the detail of the execution—or at least no way for such a division has yet been shown. The reason for this is that the general features are just the result of an infinity of detail, and there are no principles which, without harm, can be laid down irrespective of the detail. Yet, in order that in a decentralized system the individual decisions should be mutually adjusted to each other, it is of course essential that the individual entrepreneur should learn as promptly as possible about any relevant change in the conditions affecting the factors of production and the commodities with which he is concerned. Now this is precisely what the price system brings about *if* competition is functioning. It is in effect a system under which every change in conditions and opportunities is promptly and automatically registered so that the individual entrepreneur can read off, as it were, from a few gauges and in simple figures, the relevant results of everything which happens anywhere in the system with respect to the factors and commodities with which he is concerned.

This method of solving by an automatic decentralization a task which, if it had to be solved consciously, would exceed the powers of any human mind, would have been hailed as one of the most marvellous inventions—if it has been invented deliberately. Compared with it the more obvious method of solving the problem by central direction appears incredibly clumsy, primitive, and limited in scope. It is very significant that those socialist economists who have most carefully studied the practical problems of a socialist economy have more than once re-discovered competition and the price system as the best solution—only that unfortunately this system cannot work without private property[2]. For the general attitude towards the price system it has, however, been most unfortunate that it has not been deliberately invented, but that it has spontaneously grown up long before we had learnt to understand its operation. It seems to offend a deep instinct of the man of science and particularly the engineer to be asked to believe that anything which has not been deliberately constructed but is the result of a more or less accidental historical growth should be the best method for a human end. Yet the contention is of course not that by some miracle just that system has spontaneously developed which is best suited to modern civilization, but rather that the division of labour, which forms the basis of modern civilization, has been able to develop on a large scale only because man happened to tumble on the method which made this possible.

It is now sometimes argued—often by the same type of people who by their propaganda against competition have contributed largely towards its progressive suppression—that although all this is quite true, and although it would be desirable to have competition if it were still possible, technological facts prevent this, and that therefore central planning has become inevitable. This, however, is just one of the many myths which, like that of the 'potential plenty', are taken over by one propagandist work from another until they come to be regarded as established facts, although they have little relation to reality. There is no space here to discuss this point at any length, and it must suffice to quote the conclusion at which the most comprehensive recent investigaton of the facts has arrived. This is what the final report of

the investigation on the "Concentration of Economic Power", by the American Temporary National Economic Committee, has to say on the point: "It is sometimes asserted, or assumed, that large scale production, under the conditions of modern technology, is so much more efficient than small-scale production that competition must inevitably give way to monopoly as large establishments drive their smaller rivals from the field. But such generalization finds scant support in any evidence that is now at hand"[3]. Indeed few people who have watched economic development during the last twenty years or so can have much doubt that the progressive tendency towards monopoly is not the result of any spontaneous or inevitable force, but the effect of a deliberate policy of the Governments, inspired by the ideology of 'planning'. The really remarkable fact is the vitality of competition, which in spite of the persistent attempts towards its suppression is ever again raising its head—only to encounter new measures designed to stifle it.

It is a serious thing that in this situation men of science and engineers should so frequently be found leading a movement which in effect merely serves to support the unholy alliance between the monopolistic organizations of capital and labour, and that for a hundred men of science who attack competition and 'capitalism' scarcely one can be found who criticizes the restrictionist and protectionist policies which masquerade as 'planning' and which are the true cause of the 'frustration of science'. That this attitude should be so common among natural scientists can scarcely be fully explained by that characteristic bias for anything consciously constructed and against anything which has merely grown up, to which I have already alluded. It is at least as much due to the antagonism of so many natural scientists towards the teaching of economics, whose methods appear to them unfamiliar and strange, and whose results they often either disregard or, like Prof. L. Hogben, even violently attack as "the medieval rubbish taught as economics at our Universities"[4]. This conflict over the methods proper to the pursuit of the study of society is an old one and raises exceedingly complex and difficult problems. But as the prestige which the natural scientists enjoy with the public is so often used to discredit the results of the only systematic and sustained effort to increase our understanding of social phenomena, this dispute is a matter of sufficient importance to make in this context a few words of comment necessary.

If there were reason to suspect that the economists persist in their ways merely from the force of habit and in ignorance of the methods and techniques which in other fields have proved so eminently successful, there could indeed be grave doubt about the validity of their arguments. But attempts to advance the social sciences by a more or less close imitation of the methods of the natural sciences, far from being new, have been a constant feature for more than a century. The same objections against 'deductive' economics, the same proposals to make it at last 'scientific', and, it must be added, the same characteristic errors and primitive mistakes to which natural scientists approaching this field seem to be prone, have been repeated and discussed over and over again by successive generations of economists and sociologists and have led precisely nowhere. All the progress in the understanding of the phenomena which has been achieved has come from the economists patiently developing the technique which has grown out of their peculiar problems. But in their efforts they have constantly been embarrassed by famous physicists or biologists pronouncing in the name of science in favour of schemes or proposals which do not deserve serious consideration. It was expressing a common experience of all students of social problems when an American sociologist recently complained that "one of the most terrible examples of unscientific-mindedness is frequently an eminent natural, i.e., physical or biological scientist speaking on societal matters"[5].

As the dispute on central planning has become so closely connected with the dispute on the scientific validity of economics, it has been necessary briefly to refer to these matters. But this must not draw us away from our main theme. The technical inferiority or superiority of central planning over competition is not the sole or even the main problem. If the degree of economic efficiency were all that is at stake in this controversy, the dangers of a mistake would still be small compared with what they really are. But just as the alleged greater efficiency of central planning is not the only argument used in its favour, so the objections do not rest solely on its real inefficiency. It must indeed be admitted that if we wanted to make the distribution of incomes between individuals and groups conform to any predetermined absolute standard, central planning would be the only way in which this could be achieved. It could be argued—and has been argued—that it would be worth putting up with less efficiency if thereby greater distributive justice could be obtained. But unfortunately the same factors which make it possible in such a system to control the distribution of income also make it necessary to impose an arbitrary hierarchical order comprising the status of every individual and the place of practically all values of human life. In short, as is now being more and more generally recognized, economic planning inevitably leads to, and is the

cause of, the suppression of individual liberty and spiritual freedom which we know as the 'totalitarian' system. As has recently been said in Nature by two eminent American engineers, "the State founded on dictatorial authority . . .and the planned economy are essentially one and the same thing"[6].

The reasons why the adoption of a system of central planning necessarily produces a totalitarian system are fairly simple. Whoever controls the means must decide which ends they are to serve. As under modern conditions control of economic activity means control of the material means for practically all our ends, it means control over nearly all our activities. The nature of the detailed scale of values which must guide the planning makes it impossible that it should be determined by anything like democratic means. The director of the planned system would have to impose his scale of values, his hierarchy of ends, which, if it is to be sufficient to determine the plan, must include a definite order of rank in which the status of each person is laid down. If the plan is to succeed or the planner to appear successful, the people must be made to believe that the objectives chosen are the right ones. Every criticism of the plan or the ideology underlying it must be treated as sabotage. There can be no freedom of thought, no freedom of the Press, where it is necessary that everything should be governed by a single system of thought. In theory Socialism may wish to enhance freedom, but in practice every kind of collectivism consistently carried through must produce the characteristic features which Fascism, Nazism and Communism have in common. Totalitarianism is nothing but consistent collectivism, the ruthless execution of the principle that 'the whole comes before the individual' and the direction of all members of society by a single will supposed to represent the 'whole'.

It would need much more space than can be given to it here to show in detail how such a system produces a despotic control in every sphere of life, and how in particular in Germany two generations of planners have prepared the soil for Nazism. This has been demonstrated elsewhere[7]. Nor is it possible here to show why planning tends to produce intense nationalism and international conflict[8], or why, as the editors of one of the most ambitious co-operative volumes on planning discovered to his sorrow, "most 'planners' are militant nationalists"[9]. We must turn here to a more immediate danger which the present trend in Great Britain creates. It is that of a growing divergence between the economic systems here and in the United States which threatens to make impossible any real economic collaboration between the two countries after the War. In the United States the present development is well described by the programme for restoring competition developed by President Roosevelt in the message to Congress of April 1938, which, in the President's words, is based on the thesis "not that the system of free private enterprise for profit has failed in this generation, but that it has not yet been tried"[10]. Of Great Britain, on the other hand, it could be rightly said about the same time that "there are many signs that British leaders are growing accustomed to thinking in terms of national development by controlled monopolies"[11]. This means that we are following the paths on which Germany has led and which the United States is abandoning because, as states the report on the "Concentration of Economic Power" to which the President's message gave rise, "the rise of political centralism is largely the result of economic centralism"[12]. The alternative is, of course, not *laisser-faire*, as this misleading and vague term is usually understood. Much needs to be done to ensure the effectiveness of competition; and a great deal can be done *outside* the market to supplement the results. But by the attempts to supplant it we deprive ourselves not only of an instrument which we cannot replace, but also of an institution without which there can be no freedom for the individual.

Nothing in this situation deserves to be studied and pondered so much as the intellectual history of Germany during the last two generations. What has to be realized is that the features which made her what she is are largely the same as those which made her admired and which still exert their fascination; and that the corruption of the German mind came largely from the top, the intellectual and scientific leaders. Men, undoubtedly great in their way, made Germany an artificially constructed State—'organized through and through', as the Germans prided themselves. This provided the soil in which Nazism grew and in which representatives of State-organized science were found among its most enthusiastic supporters. It was the 'scientific' organization of industry which deliberately created the giant monopolies and represented them as inevitable growths fifty years before it happened in Great Britain. The very type of social doctrine which is now so popular among some British men of science began to be preached by their German counterparts in the seventies and eighties of last century. The subservience of the men of science to whatever became official doctrine began with the great development of State-organized science which is the subject of so much eulogy in Great Britain. It was the State in which everyone tended to become a State employee and in which all pursuits

for profit were held in contempt which produced the disregard and final destruction of liberty which we now witness.

I shall conclude with an illustration of what I have said about the role of some of the great men of science of Imperial Germany. The famous physiologist Emil du Bois-Reymond was one of the leaders of the movement anxious to extend the methods of natural sciences to social phenomena and one of the first and most effective advocates of the now so fashionable view that "the history of natural science is the real history of mankind"[13]. It was also he who uttered what is perhaps the most shameful statement ever made by a man of science on behalf of his fellows. "We, the University of Berlin," he proclaimed in 1870 in a public oration as rector of the University, "quartered opposite the King's palace, are, by the deed of our foundation, the intellectual bodyguard of the house of Hohenzollern"[14]. The allegiance of the German scientist-politicians has since changed, but their respect for freedom has not increased. And the phenomenon is not confined to Germany. Has not Mr. J. G. Crowther recently, in a book which develops views so similar to du Bois-Reymond's, undertaken to defend even inquisition because, in his view, it "is beneficial to science when it protects a rising class"[15]? On this view clearly all the persecutions of men of science by the Nazis after they came to power could be justified—for were not the latter then a "rising class"?

[1] P. M. S. Blackett and others, "The Frustration of Science", Allen and Unwin (1935), p. 142.

[2] H. D. Dickinson, "Economics of Socialism", Oxford University Press (1939); O. Lange and F. M. Taylor, "On the Economic Theory of Socialism", University of Minnesota Press (1938); F. A. Hayek, *Economica*, N.S., 7 (1940).

[3] Final Report of the Temporary National Economic Committee ("T.N.E.C."), U.S.A., 77th Congress, 1st Session, Senate Document No. 35, 89.

[4] L. Hogben, "Education for an Age of Plenty", British Institute of Adult Education (1937), p. 10.

[5] R. Bain, *Social Philosophy*, 230 (April, 1939).

[6] F. B. Jewett and W. R. King, NATURE, 146, 826 (1940).

[7] W. Lippmann, "The Good Society", Little, Brown and Co. (1937); M. Polanyi, "The Contempt of Freedom", Watts and Co. (1940); W. Sulzbach, *Ethics*, 50 (April, 1940); F. A. Hayek, "Freedom and the Economic System", University of Chicago Press (1939).

[8] L. Robbins, "Economic Planning and International Order", Macmillan (1937).

[9] F. Mackenzie (ed.), "Planned Society", Prentice Hall (1937), p. xx.

[10] Final Report of the T.N.E.C., p. 20.

[11] *Spectator*, 337 (March 3, 1939).

[12] Final Report of the T.N.E.C., p. 5.

[13] Emil du Bois-Reymond, "Kulturwissenschaft und Naturwissenschaft" (1879).

[14] "A Speech on the German War", Delivered on August 3, 1870, before the University of Berlin, by Emil du Bois-Reymond, at that time Rector. London, Rd. Bentley (1870), p. 31.

[15] J. G. Crowther, "The Social Relations of Science", Macmillan (1940), p. 333.

THE SCIENTIFIC APPROACH TO COLONIAL DEVELOPMENT*

BY THE RIGHT HON. LORD HAILEY, G.C.S.I., G.C.M.G., G.C.I.E.

IN discussing colonial conditions, I shall in the main limit myself to those prevailing in the British Colonies. The character of the British colonial empire was modified as a result of the expansionist policy of the latter part of the last century. The Indian Empire and Burma have, of course, never been ranked as colonies. Up to about the eighties of last century, therefore, the Colonies comprised mainly Ceylon and a small part of Malaya in the eastern hemisphere, a number of trading settlements on the coasts of Africa, and in the western hemisphere, the old British possessions in the West Indies. The period of expansion added in Africa alone an area roughly equal to that of British India, together with parts of Borneo, an extended area in Malaya, and some of the Southern Pacific islands. The new territories were largely tropical in character; but, what is more important, the majority of their populations were at a stage at which they had needs, both material and social, far greater than those of some of the older dependencies. Judged in terms of approach to our own type of civilization, they were far more backward. On the other hand, we had then available to us the result of much previous experience of colonial development; above all, we had by this time at our service an amount of knowledge regarding the employment of the applied sciences in social development which was far in advance of that possessed by our predecessors. We had another advantage. Earlier in the last century, tropical products (excluding, of course, certain of the minerals, and the precious metals) were in demand only in the luxury market of the more highly developed countries. But the rapid growth of standards of living in those countries has made the luxuries of our grandfathers the necessities of whole populations to-day. Such things as cocoa, the great range of vegetable oils, coffee or bananas are typical of the tropical products which have become essential to the general population of Europe and America, and thus can assist the tropical peoples in financing the social services needed to improve their standards of life.

We had also at our service a growing store of

* Substance of a paper read at the Conference on Science and World Order on September 27.

knowledge about the social customs of primitive peoples. It may be that the existing customs of these people in such matters as the holding of property, the regulation of conduct by tribal or community ties, and the like, has had its analogy in the past history of our own and other highly organized peoples. But we are now divided from the primitive peoples by a gulf which makes the process of their adjustment to modern civilization far more difficult than that of many of the Eastern peoples. Our anthropological study may, at the period of which I am speaking, have been interested in the form rather than in the function of custom. But we had the means of appreciating the fact that the gulf could not be suddenly closed by a hasty substitution of our own social conceptions and practices, but must be bridged by a studied adaptation of existing custom to modern uses.

I can best illustrate the character of the problem with which I have set out to deal, if I ask how far we have actually availed ourselves of these opportunities in planning the development of the new areas which the events of the latter half of the last century brought into our possession. We need not concern ourselves here with the preliminary stage through which all colonial development must pass, I mean the introduction of law and order, and the provision of those more elementary requirements, in the form of communications and the like, which will enable the population to begin building up its material existence. We are concerned here with the secondary stage, of which the chief feature is, or should be, the conscious planning of the improvement of its standards of life.

We can afford to avoid at this point any discussion as to the nature of the ultimate objective of this development—whether, for example, we desire to Europeanize the dependent peoples, or what is the nature of the synthesis between the indigenous culture and our own culture which we seek to attain. These are no doubt questions which must have their answer at some stage, but the answer is one which is in the end more likely to be provided by the dependent peoples themselves than by us. I confine myself here to matters which we cannot doubt to be within our grasp, given a due attention to careful planning and systematic execution.

We must see that the colonial peoples have that type of nutrition which will establish the necessary measure of resistance to disease. We must secure for them a subsistence adequate to provide the strength necessary for sustained effort in cultivation or industry. They must have access to medical facilities for dealing with physical disorders, epidemic or otherwise; and access to such measure of popular instruction as will enable the mass of people to adjust themselves to the needs of new economic and cultural conditions. These are fundamentals, and precondition all further social progress.

But planning, even at this early stage, cannot halt there. We interpret economics to-day in terms of welfare, not of wealth; but it is a condition of welfare that the Government should itself have the means of raising finance for capital works or for the provision of social services, and that the population should be furnished with the means of acquiring articles which a non-industrialized country must necessarily import. All the exportable assets of the territory, whether in the form of metals or of exportable crops, must therefore be turned to the best account. But this must at the same time be effected on terms which will avoid prejudice to the primary claims of subsistence production or undue disturbance to a social economy not yet adjusted to the needs of industrial life.

How far have we planned scientifically for development on the lines which I have just described? For I take it that the use of science in colonial development means just this, that we start by surveying the whole field in order to get the problems which it presents into proper alignment, and afterwards proceed systematically to their solution, using the most expert agencies available for advice as to the methods to be employed, and expending the resources at our command in the order which the relative importance of our problems indicates.

It is doubtless unduly idealistic to suggest that we could ever have proceeded on lines involving so much prevision and systematic procedure as this involves. It is at all events clear that we did not do so. We have, for example, in many instances allowed concentration on the cultivation of export crops to outweigh the needs of subsistence production, with results no doubt less disastrous than those which at one time attended the use of the culture system in the Netherlands East Indies, but sufficiently grave to require legislation compelling a minimum subsistence cultivation, in order to prevent famine. It is only in the last few years that we have inaugurated a general survey of nutritional conditions in the Colonies. It required the revelations regarding the ravages of sleeping sickness in the neighbourhood of Lake Victoria during the years 1901–1905, where we owed much to inquiries initiated by the Royal Society, to bring home to our administrations the deplorable health conditions prevailing in many parts of Africa, and there are still many areas in which no general survey of these conditions has yet been made. The extent of popular education was for long dependent on missionary initiative, and the State did not control

the curriculum. It is only of very recent years that we have realized the widespread menace of soil erosion and the need for special measures for conserving soil fertility.

Passing to another field, there are many territories where geological survey has been very superficial, and the discovery of mineral deposits has been left to the initiative of individual prospectors, who have been primarily interested only in the precious metals. Land survey has in some cases been so exiguous that railways have had to be re-aligned at great cost owing to the lack of accurate maps. Or take yet another field. Native land tenure systems have in Africa still to come under comprehensive survey, though agricultural progress must largely depend on the evolution of a definite and easily recognizable system of land rights. Recruitment of labour for industrial enterprises has not until lately been regulated by any programme based on the capacity of different areas to provide man-power without undue social disturbance or interference with subsistence cultivation. It has been left to the management of these enterprises to investigate the most suitable dietary for labour and to apply it at their own discretion.

We must readily admit the obstacles which have stood in the way of a systematic planning of development. No one can justly overlook these, just as no one should underestimate the vast improvement which we have actually made in the life of the dependent peoples, or the services which the high sense of duty of the administrative staff has rendered to them. Nor must one overlook the many contributions which have been made, especially of late years, by our scientific bodies and the labours of individual men of science. It is sometimes said, that if we have failed to be more systematic in our policy of development, it is because we are not ourselves either a very logical or a scientifically minded people. In our own national life we prefer to act on a sense of expedience rather than on principle ; we trust to improvisation rather than to logical scheming, holding that this is more flexible and more readily adjustable to the complexities of actual situations than are the results of more abstract thinking.

Our colonial policy has in the past been dominated by certain traditions derived from our own political instincts, and by the conditions in which we originally acquired jurisdiction over our dependent peoples. We saw our first duty in protecting them from exploitation and misrule and in fitting them to maintain, in a political sense, their own position in the world. That tradition was far from unworthy, but it may be that it unduly diverted our attention from the need of pursuing a constructive policy of improvement in the physical conditions and the standards of life of these people. In the second place, we have in the past tended in our own domestic life to look on the State chiefly as a political organization, and not as one of which the primary function is the promotion of the social welfare, the health and the standards of life of its citizens. This generation has seen a radical change in our conception of the functions of the State, and with it has come a new and more constructive outlook on the activities which should engage the attention of a colonial administration.

This changed conception of the functions of the State has had a marked influence on the attitude of the British public itself towards its colonial obligations. It was in the past usual to make an appeal to a sense of trusteeship, a trusteeship which, in a well-known phrase, ought to be exercised alike in the interests of dependent peoples and those of civilization. But that form of appeal had its limitations. It was capable of a great variety of interpretations, and it supplied no standard for action. It left it open to the public to feel that it could satisfy its sense of obligation by the maintenance of a humane system of administration and by taking a liberal view of the political future of its dependants. But the new conception of the functions of the State puts our colonial obligations on a concrete plane, and one with which the public is not unfamiliar.

It is the general acceptance of this new conception of the State in relation to the provision of social services which rendered it relatively easy to secure the liberal provision of funds guaranteed by the Colonial Welfare Act passed in 1940. We started at the outset with the feeling that a Colony should be self-supporting. We advanced a further stage when the Colonial Development Fund Act of 1929 made it possible to spend up to a million pounds a year on assistance to certain of the social services, or on types of inquiry which the Colonies were not able to finance. The Act of 1940, however, is a final recognition that further development cannot be achieved without more far-reaching and more consistent assistance.

It is now the task of the administrator to make a full use, and at the same time a more scientific use, of this position. Let me indicate some of the directions which the more scientific use of the opportunities now presented might profitably take. I will begin with some of our more fundamental needs. In the first place, we need to place our demographic information on a more satisfactory basis. Even the total population of some of our territories is a matter of assumption and dependable vital statistics are generally unobtainable. The extension of land survey is essential, at all events so far as regards geodetic triangulation, in order to

provide the network within which cadastral survey can be conducted as it becomes necessary. We must not repeat the experience of South Africa, which paid heavily for its delay in carrying out the scheme of triangulation put forward by Sir David Gill in the seventies of last century. Again, the fuller knowledge of our colonial assets demands an expanded service of geological survey; the discoveries made by the Government geological staff in the Gold Coast and Sierra Leone, show how ample a return the Government revenues can secure for the small outlay involved. To-day much of the energy of our small geological staff is diverted in some areas to the provision of water supplies or the regulation of mining licences. I have referred to the inauguration of a nutrition survey, a movement largely stimulated by the work of Sir John Orr and his colleagues in Kenya, but the specialist staff engaged is relatively small, and in only one or two cases has the survey been associated with the sociological survey which must be an essential part of a study of this nature. It is not enough to know if a dietary is inadequate or ill-balanced; we must know also the social habit which determines its selection or hinders the use of available substitutes.

As regards health work I have already pointed out the absence in many territories of a complete survey of health conditions. There have been studies carried out of particular localities which have proved of the highest value, but much has still to be done in this direction. Thus, to take an example from Africa, we know as yet very little about the exact range of the 'dormant' or 'silent' stage of yellow fever, and we should indeed know less but for the aid given by the Rockefeller Foundation. The incidence of tuberculosis is still unexplored, and there is reason for believing that previous assumptions on the incidence of leprosy are largely incorrect. It is essential again that we should have a more precise knowledge of the effects of tropical and particularly equatorial climates on the physical condition of Europeans. It is equally necessary that we should know whether there are any such fundamental differences in the physical constitution of tropical peoples as will effect the application to them of the European system of curative medicine.

Our work of survey must necessarily include also studies on the social side. One such is that into land tenures, to which I have already referred. Another is the study of the procedure of native marketing, on the improvement of which depends the expansion of the internal economy of the Colonies. A third is the investigation of the extent to which indigenous customary law affords a basis for the formulation of a uniform legal system which will adjust the procedure of European law to the requirements of the more primitive populations.

It is to be hoped that much of this work will become practicable when the special fund for research provided by the Act of 1940 becomes available after the War. The provision which Parliament has thus made for colonial research is in itself significant of the new order of ideas, and I know of no parallel to such a measure in other countries. But survey, though essential to systematic planning, is only part of a scientific approach to colonial development. There still remains the need for research into the wide range of specific problems arising in the field both of the applied and social sciences, which require local investigation either because they are peculiar to colonial conditions or because, though more general in character, they present features which can only be studied within the Colonies themselves.

Here I suggest that there are certain guiding considerations. It is advisable that the facilities afforded by our great imperial institutions of research should be utilized to the fullest extent and that the energies of colonial research workers should be strictly limited to problems requiring local inquiry. One is struck by the limitations imposed on the research worker by isolation alike from the assistance and the criticism of professional colleagues. The well-known study into the alleged mental deficiency of Africans made a few years ago at Nairobi would have taken a very different form if it had been made in the more critical atmosphere of a European intellectual centre. Secondly, we should seek to group colonial research workers into suitable centres and to bring their work under some form of professional direction. At present the staff engaged in research is liable to have its energies diverted to routine work, and when it undertakes longer range inquiries the subject is often dictated by its own choice or pressed on it by the local interests which are in a position to influence its services.

There arises a further problem for which I have some difficulty in suggesting a solution. It is possible to envisage group centres for agricultural, medical or similar research, each under its own professional direction. But how are the efforts of these different departments of inquiry to be co-ordinated? Few of the major problems of the Colonies can be solved by specialists in one branch of inquiry alone. What agency is there which can exercise joint direction over these different interests in research, or at all events decide the relative importance of their application in practice? That is a question to which the lay administrator would certainly welcome an answer.

Let me add one final consideration. I have purposely refrained from instituting comparisons which might suggest that other colonial powers have given either greater or less attention to

scientific planning than we have ourselves. I have therefore made no reference to the extensive study of the economics of production made by the Dutch in their East Indies, or the use made in the French Colonies of their metropolitan research institutions, such as the Pasteur Institute, of the scientific approach made by the Belgians to certain aspects of medical work and to the problems of labour supply, or the unusually extensive programme of scientific inquiries with which Italy inaugurated its regime in Ethiopia. But if any lesson would seem likely to emerge from such a comparison it is this. Admitting a certain difference in policy and ideals, there is a very striking resemblance in our concrete problems. That we should seek for every means of co-operation in solving them is so obvious as to be commonplace. But how far does this co-operation extend at present ? In one sense, of course, all scientific inquiry is co-operative in so far as its published results are the common possession of all men of science. We have again had instances, though not as many as might be expected, of international conferences on scientific subjects which have a bearing on colonial development. But there are not many instances of combined planning for dealing with specific problems in the field of the applied or social sciences. An outstanding instance to the contrary is that of anti-locust research, which has become largely international in character. There are perhaps other instances, but they must be few. Their restricted scope justifies, at all events, the suggestion that a modern world which can combine to control the production of tea or rubber, or tin, or copper, in the interests of an investing public, might well find the means of exhibiting a greater solidarity in dealing with issues vital to the welfare of the colonial peoples.

OBITUARIES

Prof. N. K. Koltzov

ON December 2, 1940, science suffered a severe loss in the death of Nicolai K. Koltzov, the great Russian biologist. Born in Moscow in 1872 and educated at the University of Moscow, Koltzov began research as a comparative anatomist and his first paper was on the development of the amphibian pelvis. Other early work of his was in the direction of the development of the head, especially in cyclostomes.

When Koltzov turned his attention, however, to the structure of spermatozoa, beginning with those of the decapod Crustacea, which are extremely elaborate, he found himself entering a line of work which was to continue throughout his life. From 1905 onwards he was more and more fascinated by the structures in cells which seem to maintain their morphological shape. While others arrived at the conception of fibre-molecules, anisometric polymerized particles, etc., from the study of mammalian muscle fibres, Koltzov approached it from the study of cells such as crustacean spermatozoa and contractile fibres such as the stalks of Vorticella. Already in 1912, long before any X-ray analysis had been applied to fibres of biological origin, Koltzov proposed in *Priroda* that much of the morphology of cells is due to the actual shape of the molecules within them. Even in 1928, when he elaborated these views in a classical paper in the *Biologisches Centralblatt*, he had little more to go upon than the polypeptide chain conceptions of Emil Fischer. The establishment of the anisometric character of myosin particles by optical and viscosimetric methods did not come to confirm him until after 1930. In Russia the view that the shape of cells is determined largely by "solid" protoplasmic "skeletal" elements immersed in more liquid or semi-liquid protoplasm, is known as "Koltzov's Principle", and as time goes on this term may come to be more widely used. In 1928, too, Koltzov suggested that the chromosome might perhaps be regarded as a protein giant-molecule, of which genes might be side-chains ; a conception which has since been found stimulating and fruitful.

Koltzov's papers, not very numerous, but all on fundamental problems, were collected into a book "Organisatsia Kletke" ("The Organization of the Cell" ; Moscow, 1936) but he also published two excellent monographs, "Physiologie du Développement et Génétique" (Paris, 1935) and "Les Molécules Héréditaires" (Paris, 1939). Besides his researches, he founded in 1917 in Moscow the first Institute of Experimental Biology in Russia, of which for the rest of his life he was the loved and respected leader. He also founded and edited, until his death, the *Biologicheskij Zhurnal*, known to many British biologists. Among his students and colleagues were names so well known internationally as Zavadovsky, Serebrovsky, Efimov, Astaurov, Dubinin, Epstein, Filatov, Lopaschov and Manuilova.

I had the great pleasure of visiting Prof. Koltzov and his wife (also a research worker) in their laboratory and institute in 1935, and of appreciating the admirable atmosphere of collaborative work which reigned there among all its members. On November 27, 1940, Koltzov was interrupted in his work by a sudden heart attack. He was preparing a lecture which he would have delivered at the February, 1941, meeting of the Moscow Society of Naturalists. Its title was "Morphology and Chemistry". It was typical of him, this choice of a fundamental subject,

and it summarized the aim to which his whole life had been devoted. Had it not been for the fact that he remained primarily a biologist to the end, thus lessening somewhat the parallelism between their lives, we might well have come to think of him as the Russian W. B. Hardy. JOSEPH NEEDHAM.

Mr. I. O. Griffith

By the sudden death of Mr. I. O. Griffith on September 22, the day before his sixty-first birthday, the University of Oxford, and especially the science faculties, have lost more than can be easily measured. As member of the Hebdomadal Council, vice-chairman of the General Board, chairman of the Board of Faculty, treasurer of the Natural Science Club, he held a key position in the scientific administration in the University. Whatever the branch of science and however remote from his own special loves, mathematics and physics, he could always be counted upon to make every effort to help to bring a project to fruition. He will be indeed difficult to replace in the councils of the University.

After his distinguished flying work, mainly on the navigational side, in the R.A.F., during 1914–18, which earned him the Air Force Cross, he returned to Oxford as senior demonstrator in the Clarendon Laboratory. Always keenly interested in teaching he was mainly responsible for building up the advanced course and organizing the expansion of the Department which trebled or quadrupled its activities during his period of office. His work on the measurement of temperature in the high-pressure arc led on to the well-known monograph on photographic photometry published by himself and Dr. Dobson. But his conscientious devotion to his students' interest left him scant time for research, and it is in their activities and records that his main contributions to physics will be discerned.

The departure of many of his younger colleagues since the outbreak of war left him with more teaching than ever to do. Always ready to help, he had one task after another thrust upon him. True to his old service, he accepted the important and onerous duty of looking after the Air Force cadets in the University and organizing their teaching. No better choice could have been made, and the immediate success of the scheme is evidence of his tireless work and administrative ability.

It is impossible to describe Griffith's peculiar personal charm in words. Invariably cheerful and friendly, he could be relied on to face an acrimonious debate on the Board of Faculty or a critical situation in a crucial golf match with equal adequacy. Free from any thought of self, he devoted all his efforts to the advantage of his pupils and his colleagues. A keen member of his College, he never allowed parochial patriotism to over-ride his devotion to the interests of the University. His balanced judgment confuted those who delight to paint the average don as a creature of moods and foibles with an outlook bounded by curricula and examinations. Void of the glitter and clash of more metallic personalities he did great work for his University and his country which will bear fruit long after the more strident voices, which so easily gain popular acclaim, have died away.

Prof. R. B. Wild

It is with regret that we record the death on October 7 of Prof. R. B. Wild, emeritus professor of materia medica and therapeutics in the University of Manchester.

Educated at Owens College, Prof. Wild was associated with Manchester throughout his active career. After serving for a time as an assistant lecturer in the Department of Pathology he transferred his affection to the subjects of pharmacology and therapeutics and joined the staff of the late Prof. D. J. Leech. The two men developed an active Department in which important work in experimental pharmacology was done, the most significant being a study of the effects of the nitrites upon the circulatory system. One of the results of their researches was the recognition of amyl nitrite as an official preparation.

On the death of Leech in 1900, Wild was elected to the chair and in 1919 became the first whole-time Leech professor of materia medica and therapeutics. When in consulting practice, Wild was recognized as an authority on dermatology and he wrote a number of papers on diseases of the skin. For many years he was intimately associated with the Christie Cancer Pavilion and Home; he was responsible for the medical side of the work and played a leading part in the administration of the institution. Throughout his teaching career he was untiring in his efforts to develop and improve the Faculty of Medicine and his contributions to medical education were of the greatest value. For a time he was dean of the Medical School and the representative of the University on the General Medical Council. As a member of Senate he took a prominent part in general University affairs and acted for a period as one of the pro-vice-chancellors. He retired in 1927, when he ceased to live in Manchester, but still kept in touch with the University and city which he served so conscientiously and well. J. S. B. STOPFORD.

We regret to announce the following deaths:

Mr. W. A. Bailey, chief conservator of forests, Indian Forest Service, on July 14.

Mr. Norman de Garis Davies, the well-known Egyptologist, on November 5, aged seventy-six.

Dr. Walter Granger, curator of fossil mammals in the American Museum of Natural History, on September 6, aged sixty-eight.

Prof. C. M. Sparrow, professor of physics in the University of Virginia, on August 30, aged sixty-one.

Prof. T. H. Taliaferro, professor of mathematics in the University of Maryland, on September 25, aged seventy.

NEWS AND VIEWS

Science Clubs of America

A NATIONAL science activity, Science Clubs of America, is being sponsored by Science Service, the American science news service. In every locality throughout the country there will be groups active in various fields of science. Science clubs in high schools will be encouraged and given the opportunity of joining in the national movement and entering into national activities. Groups of enthusiastic amateurs in science—grinding telescope mirrors, collecting insects, breeding new plants, collecting minerals, or pursuing scores of other interesting avocations—will join in this important development. As the nucleus of Science Clubs of America, there are more than eight hundred junior clubs which have been organized during the past fourteen years by the American Institute of the City of New York. These clubs exist not only in the United States but also in Puerto Rico, Hawaii, the Philippines, British West Indies, Alaska, Canada, and even Portugal. An advisory committee on Science Clubs of America, representing jointly the American Institute and Science Service, is being formed.

Excavations in Alaska

Dr. H. L. Shapiro and Dr. F. G. Rainey, of the American Museum of Natural History, have been excavating five hundred arctic tombs at Point Hope, Alaska. The five hundred skeletons are said to form one of the largest collections of the sort ever found at a site in America. The two anthropologists sought remains of an ancient and unknown people, whom Dr. Rainey first discovered in expeditions of 1939 and 1940. Also they sought later Eskimo burials which would aid in showing what relationship the lost ancients had to the later Eskimos. The mysterious unknown people had a remarkably big town with well-planned streets, more than a hundred miles north of the Arctic Circle; and about two thousand years ago they abandoned this settlement. They are looked upon as a lost race, because their ivory arts are unlike those of known Alaskan Eskimos, ancient or modern. Also, it is explained, they lacked many typical Eskimo implements, and were more dependent on land than on the sea for their resources.

Dr. Shapiro plans to examine the physical traits of the forgotten northerners, to place them more definitely in the story of prehistoric America. The Ipiutaks, as they are now called from the Eskimo name of a spit of land near their old home, may have come from as far away in Asia as north China, according to one suggestion. A new glimpse into curious burial customs of the Ipiutaks is revealed by a carved ivory mask with staring inset ivory eyes, which was found covering the body of a little child. The child lay resting on the knees of a man, and a woman also accompanies it. Masks with ivory eyes have been found before in the graves of these mystery people, but what their significance was for a future life remains one of the unsolved puzzles of the arctic.

Koalas in Australia

A CENSUS of koalas on Phillip Island, Victoria, was taken this year with the aid of school-children, and, we are informed by Sir James Barrett, the count shows a record population of 590, a natural increase of thirty-nine over the number shown after the census of July 1939. Many *Eucalyptus viminalis* and red gum, on which the animals feed, are being planted. The koalas are now confined to the eastern fringe of the Australian mainland, from southern Queensland to Victoria. They used to be present in South Australia, but, apart from some imported from Victoria and maintained in sanctuaries, it is doubtful if there are any there now. According to *Wild Life*, the Australian nature magazine, the combined Victorian population is somewhere between 900 and 1,100 individuals. This compares very unfavourably with the number of koala pelts marketed during 1920 and 1921, namely, 205,679.

The koala fur is remarkably warm and is practically indestructible, a jacket made of it often being passed down from father to son for several generations. This, no doubt, accounts for the dwindling of the koala. Other factors have been deforestation, disease, and, above all, bush fires. The last-named is the prevalent danger. Steps are being taken to combat this, expecially on Phillip Island, where efforts are also being made to supply an abundance of natural food and shelter in open sanctuary conditions. Two large areas have been set aside for the purpose, one of 256 acres and the other of 160 acres. Money is still required for this conservation. It is estimated that a preliminary grant in Victoria of £500 a year would enable the work to be carried on satisfactorily; and it is to be hoped that such a comparatively small sum will soon be assured, preferably from the various Australian Governments, or from the natural history societies or private individuals.

Trees and their Care

IN the July–September issue of *Trees*, the journal of the Men of the Trees, it is stated that the money already received in connexion with the Million Shilling Fund has enabled about 90,000 trees, hardwoods and softwoods, to be planted in Great Britain. Exception appears to have been taken to the fact that some of these trees have been presented to landowners who have already been paid for timber supplied for war purposes. It is said in defence that since these people have trained foresters and planters, the trees will be better looked after; but surely the man who can afford to maintain a trained forester can afford the mere price of the plants necessary to replant felled areas. It is difficult to

see any justification in supplying him from a fund of small subscriptions given, presumably, by a tree-loving public.

In a brief note elsewhere "To Intending Planters", by H. E. Seaton, the sound advice is given, in deciding upon planting schemes, to remember that "pure woods of alien trees are not modern practice; but that mixed woods of trees which do well locally are likely to succeed and are fairly fool-proof". How often has this been forgotten, even by those professing forestry knowledge. "Tree Shelter for Cattle", by S. F. B. Lane, is a much-needed reminder to farmers of the dangers being introduced in many parts of Britain by the indiscriminate tree felling which is taking place. Not only cattle, but also crops will suffer from the resultant exposure. An interesting article by H. E. Seaton on "Sewage and Civilization" (reprinted from the Rotary Service, Nov. 1940) sums up research work carried out by, among others, Dr. McCarrison and Sir Albert Howard in connexion with obtaining the present food for man and beast by a future suitable treatment of soils.

The British Empire Naturalists' Association

THE twentieth issue of the quarterly bulletin of the British Empire Naturalists' Association contains its usual summary of current field records and also the interesting announcement of the revival in octavo form, as in the War of 1914–18, of its well-known journal *Country-Side*, which had to be suspended at the outbreak of war. This decision is made possible with the very considerable—perhaps unexpected—interest in field natural history that has been maintained in Great Britain despite the War, and often in the most heavily raided centres like London and Merseyside. The first issue of the new abbreviated form of this journal is expected in December.

Among botanical records in the autumn issue of the bulletin are creeping bellflower (*C. ranunculoides*) and willow-leaved spiræa (*S. salicifolia*) in the Cotswolds, thorn-apple (Datura) spreading over bomb craters in Kent and greater spearwort at Chippenham, Wiltshire. Entomological records show a very wide distribution of the clouded yellow butterfly during its immigration from the Continent this summer, records extending into Scotland. The pale clouded yellow is recorded from Cheshire, several white admirals from the Borough Green area of Kent and the Ruislip area of Middlesex, high brown fritillaries from the west Lancashire dunes, and the marbled white at Chippenham, Wiltshire. Ornithological reports include the black-necked grebe, white wagtail and shoveler nesting in Cheshire, and little gull, spotted redshank, greenshank, and sandwich tern on migration; grasshopper warbler nesting in Lancashire, and the little gull and red-necked phalarope on migration.

Future of Telecommunications

IN an address before the London Students' Section of the Institution of Electrical Engineers on October 15, Dr. W. G. Radley, of the Post Office Research Station at Dollis Hill, spoke on Telecommunications of the future. He pointed out that in 1914, although wire telephony had been in use for about forty years and had become an important factor in the social and business life of urban communities, the loss in speech power during transmission imposed definite limits to long-distance conversations. These limits disappeared as a result of the general introduction of thermionic valve amplifiers. Later on, the long-distance circuits which became possible were made cheaper by the development of systems of carrier-current telephony, culminating in a standard system providing twelve speech channels over one pair of wires. A novel form of co-axial cable followed. This was capable of transmitting television or providing several hundred speech channels over two conductors. In the meantime, the transmission of speech by radio had made world-wide telephony possible. Each of these developments was the result of a long period of experimental work.

From the position of research work in 1939, it is possible to hazard a guess at the nature of the telephone system during the post-war period. The disappearance of metallic conductors, and the development of long-distance speech transmission by means of what is virtually guided radio waves, is a future possibility. Research into the nature of speech sounds has made it possible recently to construct a machine which will speak under the control of an operator at a keyboard. An extension of this idea suggests the possibility of analysing speech in a local circuit, transmitting signals over the long-distance line corresponding to the results of the analysis and at the distant end automatically reconstructing the speech. The frequency band necessary for transmission of the signals over the long-distance line is very much narrower than that necessary for ordinary telephony, and this would enable more circuits to be obtained from long expensive submarine telephone cables. Improvements during the post-war period would probably lead eventually to the disappearance of telephone operators, except for special services. Improved fidelity of response of microphones and telephone receivers was foreshadowed, but no immediate change in principle.

The Royal Observatory, Cape of Good Hope

THE report for 1940 of H.M. Astronomer at the Cape of Good Hope illustrates how astronomical work in the belligerent countries is being affected even though they may be far removed from the present scene of hostilities. Half the observing staff at the Cape is now engaged on non-astronomical duties, this at a time when so many observatories in Europe have perforce suspended work. Nevertheless the depleted staff is doing its best to secure such observations as cannot be replaced by any made at a later date. Meridian observations of the moon have been started in view of the possible loss of European observations, and volunteers have come to the rescue in observing occultations. Photographic work has been somewhat precarious owing to delays in the delivery of plates, but few photographs have been lost, and the position has been eased by a modification of the programme of routine

solar observations which supplements that still being carried on at Greenwich. Work on the Reversible Transit Circle continues on a somewhat reduced scale, and the photometric observations are now sufficiently far advanced to make possible the construction of a framework of stars of magnitudes between 7 and 10 to which the magnitudes of the zone stars can be referred. With the 1940 batch of parallaxes the Observatory now enters the very restricted list of stations at which the distances of more than a thousand stars have been determined trigonometrically.

The section of the report which will be read with perhaps the greatest interest concerns the total solar eclipse of October 1, 1940. The main part of the programme was to measure the gravitational deflexion of light in the sun's field—the Einstein effect. The Greenwich expedition which was to have co-operated in this work was cancelled at the outbreak of war, and the entire programme was carried through, as planned, by the Cape staff. It is disappointing to have to record total failure in this part of the work. The field of stars close to the eclipsed sun was known beforehand to be a poor one; but eclipses are so few and far between that the attempt seemed justified. In fact, the lessened exposure time and reduced aperture necessary to prevent fogging of the plates by the rather bright sky, combined with the poor daytime 'seeing' on the Karroo to prevent any stars showing on the negatives at all. Astronomers all over the world will sympathize with H.M. Astronomer and his staff in this disappointment, particularly as observing conditions were otherwise good. Their sole compensation was in securing the only large-scale photographs of the corona obtained during this eclipse—photographs which, though interesting and indeed important, represent a most inadequate reward for months of work.

Prevention of Blindness

IN its annual report for 1940 the United States National Society for the Prevention of Blindness stresses the increase in eye accidents brought about by extension of industrial production made necessary by national defence. Many firms are now using the industrial film known as "The Eyes Have It", which has been made available to the Society without cost by the Pullman Society. The Society is now planning an evaluation of vision-testing procedure used with school children and pre-school children in the hope of establishing a uniform procedure. During 1940 the National League for Nursing Education began a study of nursing education in sight conservation in co-operation with the Society. The Society has also arranged to co-operate with similar organizations in Latin America, has prepared an exhibition on glaucoma, and has continued its campaign to reduce blindness caused by venereal disease and fireworks.

Earthquake in the Argentine

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentre of the earthquake of July 3 at 7h. 11·7m. U.T. as being at lat. 33° S., long. 68° W. The calculations have been based on reports from eleven seismograph stations. The epicentre is situated near the railway line about midway between Mendoza and San Luis. Activity in this region has been much less severe and more infrequent than between 1750 and 1910. There was a strong earthquake at Mendoza on May 22, 1782, though this was surpassed by the terrific shock in the same area which caused widespread destruction on March 20, 1861. Prior to this latter shock, San Luis was destroyed on April 9, 1849. Further intense shocks were experienced in both places up to about 1910. It may be that, following the catastrophic shock of January 24, 1939, at Chillan in Chile (NATURE, Feb. 11, 1939, p. 230), the centre of activity has moved eastwards. The earthquake of July 11, 1941, at 1h. 16·6m. U.T. had its epicentre in the Pacific Ocean between the Galapagos Islands and the Isthmus of Panama.

University of Cambridge

UNDER the will of Mr. Alfred Corner, of Staverton Road, Brondesbury Park, London, who died in 1934, the University has received £1,440 for the sole purposes of the Cambridge University Biochemical Laboratory. The full value of the bequest of which this is an instalment may approach £1,800.

The professorship of animal pathology will be vacated on December 31 by the resignation of Prof. T. Dalling.

Announcements

SIR HENRY DALE, president of the Royal Society, has been awarded the Gold Medal for 1941 of the Royal Society of Medicine. The Medal is given triennially for "valuable contributions to the science and art of medicine".

THE RIGHT HON. LORD CHATFIELD, recently Minister for the Co-ordination of Defence, has been elected president of the Institution of Naval Architects in succession to the late Lord Stonehaven.

MR. R. A. WATSON WATT, scientific adviser on telecommunications to the Air Ministry, has been elected president of the Association of Scientific Workers in succession to Prof. F. G. Donnan.

IN connexion with the fiftieth anniversary of the University of Chicago which was celebrated a short time ago, the sum of 9,200,000 dollars has already been subscribed by the citizens of Chicago towards an anniversary fund of 12,000,000 dollars. It is planned to raise the balance over a period of five years.

DR. P. C. Koller and C. Auerbach, of the Institute of Animal Genetics, University of Edinburgh, writing with reference to their letter "Chromosome Breakage and Sterility in the Mouse" which appeared in NATURE of October 25, p. 501, wish to withdraw the last two sentences in the first paragraph of column 2 beginning with "We can confirm . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Non-precipitating Protein Antigens

WHEN some protein antigens are heated with serologically unspecific proteins they cease to be precipitated by their antisera, and their behaviour *in vitro* approximates to that of non-precipitating haptens[1]. Evidence from different sources suggests that this change in behaviour is brought about by the antigens combining with the other protein during the early stages of heat denaturation to form complexes, which after combination with antibodies still remain soluble.

We have now studied such complexes *in vivo* and find that they differ from haptens in being active as producers of antibodies. The antigens we used were tomato bushy stunt virus and whole globulin from human serum. These were turned into non-precipitating complexes by heating them in the presence of rabbit serum albumin in physiological saline at pH 7·0. 0·1 per cent solutions of bushy stunt virus were heated for 10 minutes at 83° C. in the presence of 0·5 per cent rabbit albumin, and 0·1 per cent solutions of human globulin were heated for 5 minutes at 100° C. in the presence of 0·2 per cent rabbit albumin. None of the sera produced by injecting rabbits with solutions of these complexes precipitated the materials used for immunization. The serum produced against the virus-albumin complex, however, precipitated solutions of both unheated virus and virus heated in the absence of rabbit albumin; indeed, no differences have been detected between this serum and those produced by injecting rabbits with virus only. The serum produced against the globulin-albumin complex precipitated solutions of the globulin heated in the absence of the albumin. In other words, although the immunizing systems were active in producing precipitating antibodies, these could be demonstrated only when one component of the system free from the other was used as a test antigen.

It is possible that these complexes are split in the rabbit before acting immunologically, so that the antigenic component is liberated and acts alone in the production of antibodies. Whether this is so or not, it should be realized that failure to obtain a positive precipitin test between an antiserum and the material used for its preparation cannot be regarded as proof that no precipitating antibodies have been formed, for complexes behaving like those we have produced by heating may occur naturally.

Complement fixation provides a suitable test for the antigenicity of such non-precipitating complexes. With antisera prepared against either the virus or against the virus-albumin complex, solutions of the virus-albumin complex fix complement as strongly as solutions of the virus alone. Similarly, the globulin-albumin complex fixes complement with antisera to the unheated globulin and with those prepared against the complex itself. This fixation of complement equally by an antiserum with antigens with which precipitation does and does not occur is evidence for the independence of the two reactions, and strongly supports the view that complement is fixed by the union of antigen and antibody and not by the formation of a precipitate.

F. C. BAWDEN.
A. KLECZKOWSKI.
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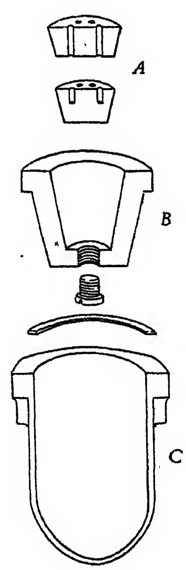
[1] Bawden, F. C., and Kleczkowski, A., *Brit. J. Exp. Path.*, 22, 208 (1941).

A New Capillary Cell for Measuring the Rate of Sedimentation of Virus Particles in a Centrifugal Field

ELFORD[1] has developed a method of particle size determination by centrifuging solutions in inverted capillaries. The sedimentation within the capillaries fulfils Stokes's law, that is, there is a uniform movement of the particles until the boundary approaches the lower open end of the capillary. At this point the boundary comes in contact with disturbing effects such as vibrations and heat convection currents in the outer fluid. These effects tend to reduce the true rate of sedimentation.

In order to eliminate these disturbing effects on the sedimentation in the capillaries I have constructed a new type of capillary cell as illustrated in the accompanying figure.



× ½

A is a cone made of M.V.C. alloy in which a series of capillaries are drilled in such a way that those of the upper section coincide accurately with those of the lower section, into which they extend a few millimetres. The two sections of the cone fit in a conical cup B made of the same metal. The cup is provided with a screw at the bottom which enables the cone to be forced out without disturbance after centrifugation. Four vertical grooves are cut into the inner surface of the cups. The cup, together with the conical cell, is supported by means of a rubber washer on the rim of the centrifuge cup.

The method of using this cell is as follows:

The surface between the two sections of the cone is smeared with a thin layer of a paste made of a mixture of beeswax and wool grease, and the two sections pushed together. Care should be taken to ensure that the capillaries of the two sections coincide accurately. Some of the fluid to be centrifuged is then placed in the cup, and the cone with

the capillaries carefully dropped in to replace this fluid. The thin layer of fluid between the conical cup and the cone and in the grooves counteracts the hydrostatic pressure inside the capillaries. This effect eliminates the movement of the fluid during centrifugation. At this stage the capillaries are filled with the help of a fine pipette with the solution to be centrifuged, and the open ends are sealed off with molten paraffin wax.

After centrifugation for the required length of time the cone in the metal cup is removed by pressing it out from below by means of a metal rod. The capillaries in the top section are then cut off from those in the lower section by turning the two sections in opposite directions. This enables the fluid in the capillaries to be removed by means of a fine pipette and analysed.

Test runs with horse sickness virus (diameter 46 mμ. Polson, in press) have shown that the titre can be reduced from 10,000 m.i.d. to almost zero in the required length of time. The remaining trace of virus is probably left behind through adsorption on the sides of the capillaries, or due to the capillaries not being sector shaped. However, when virus solutions low in titre, that is, 100 m.i.d., were centrifuged, the titres were reduced to zero, which proves that the disturbing effects occurring in Elford's inverted capillary method were eliminated.

This method of centrifugation has also been applied to a study of blue tongue virus. The size determined for the virus of blue tongue, 87–105*m*μ, compared well with that determined by ultrafiltration through Elford's gradacol membranes, namely, 100–132*m*μ.

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Sept. 11.

[1] "Handbuch der Virusforschung." Erste Hälfte. Doerr und Hallauer. Wien, Julius Springer. p. 195 (1938).

Rapid Determination of Water in Animals and Plants

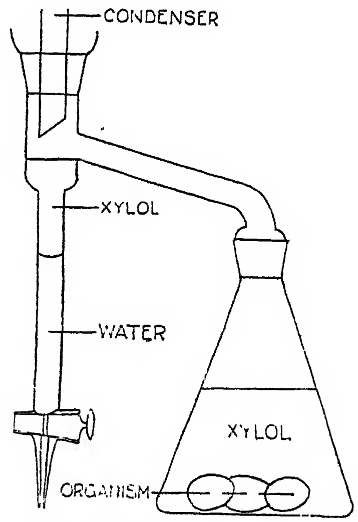
THE quickest and also the most accurate method of determining the percentage of water in animals or plants or tissues in general is a simple modification of the recognized method of determining the percentage of water in oils by means of a Dean and Stark's tube.

The animal or plant is placed in the distilling flask and covered with several times its own volume of xylol and heated over an electric heater. The xylol boils at about 135° C. and hence steam and xylol vapour distil off and are condensed. The water and xylol fall into the graduated tube and since the water is heavier than the xylol and is not miscible with it, it sinks to the bottom of the tube and for ordinary purposes its volume can be read off directly.

The same thing can be accomplished with an ordinary Soxhlet extractor provided with an outlet tap, and thus much larger quantities of water can be dealt with. The siphon tube is blocked with a little mercury. Steam and xylol are driven off as before and the water collects under the xylol.

After distillation, and when the apparatus is cold, the mercury, water and xylol are run off through the tap into a suitable graduated cylinder and the volume of water read as so many grams, but for really accurate work the height of the water is read and then the water and xylol are thrown away but the mercury is dried and returned to the same cylinder after it is clean and dry. A little xylol is added and distilled water is run in from a standard burette to the proper graduation mark. Then the same volume of distilled water is run in from the same burette into a flask and weighed. Distillation is complete when clear xylol settles in the extractor, for so long as water is coming off the xylol is cloudy.

The percentage error, which should certainly be below 0·5, is easily ascertained by distilling a known weight of distilled water under xylol and ascertaining the weight of water recovered. Paraffin cannot be substituted for xylol as its boiling point steadily rises. The percentage of distilled water in the Plymouth sea-water has been determined in this way and found to be 96·8 per cent (actually 96·796 per cent).



The great advantage of this method is its quickness and accuracy. Recently I determined the percentage of water in an ordinary hen's egg by this method and found it to be 65·4 per cent, which agrees closely with the figure given by Lebbin (65·16 per cent)[1]. The distillation took just an hour.

The alternative method of driving off the water in an oven has many disadvantages. If the material is not heated up to 110° C. all the water will not be driven off, while if it is, a good deal besides water will be driven off.

In the distillation method volatile products other than water are absorbed by the xylol; thus no difference is made to the result and so one can heat up to 135° C. without danger of decomposing the tissues. Cane sugar is charred at this temperature with prolonged distillation, but so far as I have been able to ascertain nothing else is affected. The method has been used at Plymouth for the last two years for determining the percentage of water in marine animals after they have been weighed by the displacement method[2].

Glass-ground jointing is essential and the complete apparatus with interchangeable parts is supplied by W. and J. George, Ltd., Birmingham. Fish livers are investigated as follows. They are weighed and

placed in a Soxhlet extraction thimble. This is placed in the distillation flask and the water estimated. Then the thimble with the residue is transferred to a clean extractor and the xylol removed by extraction with acetone. The remaining extract is dried and weighed and ashed if necessary. Thus at practically one distillation one can get the water, non-soluble residue, and the fat by difference. The percentage of water in mice has been found by this method. Of course it varies slightly but is always very close to 64 per cent.

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Oct. 19.

[1] Needham, J., "Chemical Embryology" (Cambridge, 1931).
[2] Lowndes, A. G., NATURE, 141, 239 (1938).

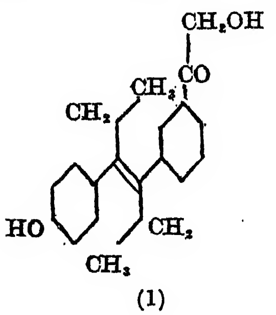
Synthetic Compounds Possessing Biological Activity Similar to that of Deoxycorticosterone

IN 1938, Dodds, Goldberg, Lawson, and Robinson[1] compared the carbon skeleton of 4 : 4′-dihydroxy-α : β-diethylstilbene (stilbœstrol) with those of œstrone and chrysene. The similarities in molecular architecture may be significant. If this be so, the possibility arises that the α : β-diethylstilbene molecule might have a similar significance in the realm of synthetic, as the condensed ring system has in the natural, sex hormones.

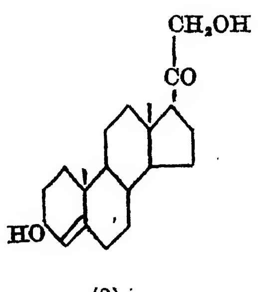
Three years ago it was decided to test the validity of this contention by applying it to the production of substances which might exhibit a similar action to deoxycorticosterone. It was first necessary to establish the importance of the -$CO.CH_2OH$ radical, and hence a series of substances possessing the general formula $R.CO.CH_2OH$ was prepared[2]. When R was aliphatic (CH_3 to C_6H_{13}), the compounds yielded osazones with 2 : 4-dinitrophenylhydrazine, but when R was cyclic (phenyl, *p*-hydroxyphenyl, cyclohexyl), hydrazones alone were formed. All the compounds reduced ammoniacal silver nitrate solution and Fehling's solution in the cold. Preliminary trials showed that of all the compounds prepared, benzoyl carbinol alone showed the desired biological activity.

The activity of this simple molecule stimulated endeavours to obtain a stilbene derivative (1) which showed a similar relationship to deoxycorticosterone (2) as stilbœstrol does to œstradiol.

Compound (1) has been obtained in the following way: *m*-nitrophenylacetyl chloride was condensed



(1)



(2)

with anisol to yield 3-nitro-4′-methoxydeoxybenzoin, which was converted into the 3-carboxy derivative *via* the amine and cyanide. Ethylation of this acid, followed by treatment of the product with ethyl magnesium iodide, gave a product that lost water on warming with iodine, yielding 3-carboxy-4′-methoxy-α : β-diethylstilbene. This compound was demethylated and the acid chloride of the acetate was converted into (1) by treatment with diazomethane followed by hydrolysis.

3′(Hydroxyaceto) 4 - hydroxy - α : β - diethylstilbene was obtained as a white solid melting at 65-67° C. It possessed chemical properties similar to the other examples of $R.CO.CH_2OH$. We are indebted to Prof. J. H. Gaddum (vice Dr. K. Coward) for the biological tests of these substances. The substances were examined for their ability to increase the survival time of young adrenalectomized rats. Comparison was made with the effect of deoxycorticosterone acetate and also with a group of negative control rats which received a daily injection of the diluent, arachis oil. Of the compounds examined, only benzoyl carbinol and 3′-hydroxyaceto-4-hydroxy-α : β-diethylstilbene showed activity, the former possessing 1/2500 and the latter something less than 1/200 of that of deoxycorticosterone. The figure obtained for benzoyl carbinol was obtained on more than one occasion, but that for the stilbene derivative is less definite. We believe that this is the first instance of purely synthetic substances showing activity similar to deoxycorticosterone. It is interesting to note that *p*-hydroxybenzoyl carbinol and cyclohexyl carbinol were inactive.

The possession of 3′-carboxy-4-hydroxy-α : β-diethylstilbene, a necessary intermediate in this work, afforded the opportunity of preparing 3′-aceto-4-hydroxy-α : β-diethylstilbene—a substance which may be regarded as the diethylstilbene analogue of progesterone. This substance has been obtained, but the reports on its examination for progesterone-like activity are not yet to hand.

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Oct. 22.

[1] Dodds, E. C., Goldberg, L., Lawson, W., and Robinson, R., NATURE, 141, 247 (1938).
[2] Linnell, W. H., and Roushdi, I. M., *Quart. J. Pharm. Pharmacol.*, 12, 252 (1939).

An Iron-Copper-Nucleoprotein Complex in Animal Tissue

IN the course of investigations on the availability of iron in fish and other animal tissues, it appears that a more correct figure for the nutritionally available iron would be obtained if the tissue is treated with 10 per cent acetic acid or digested with pepsin before the material is assayed by Hill's dipyridyl method. Further work has shown that 30–40 per cent of the total non-hæmin iron of several animal tissues consists of an iron-copper-nucleoprotein complex, which has been obtained in a fairly pure state. The copper seems to be loosely combined; it

is easily split off by trichloroacetic acid and also by alkali. The iron is also split off by alkali. Controlled experiments with anæmic rats on hæmoglobin-building indicate that this complex (or rather its breakdown products, after absorption) may be a precursor for the formation of hæmoglobin. Previous elimination of copper from this complex has been found to diminish its hæmopoietic power. Quantities of iron and copper corresponding to a given quantity of the complex, when fed to animals, have considerably less potency regarding hæmoglobin formation than the original complex, which would indicate the importance of the organic moiety for hæmoglobin building.

Further work is in progress and the results are being published in the *Annals of Biochemistry and Experimental Medicine*.

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Sept. 6.

Decreased Ovarian Response to Chorionic Gonadotropin following Hysterectomy in the Mouse

MANY attempts have been made to demonstrate a possible endocrine influence of the uterus upon the ovaries of animals. The most recent report dealing with this subject[1] describes degenerative changes in the ovaries of hysterectomized rabbits. An extract of rabbit endometrium appeared to retard the process of ovarian atrophy in another group of hysterectomized rabbits. The authors suggest that a protective influence upon the ovary is exerted by the uterus. Some clinical reports support the observation that conservation of some endometrium at the time of hysterectomy in the human lessens the severity of the menopausal syndrome following such an operation[2]. Other investigators leave the subject an open question.

That ovarian activity may be influenced by the uterus is suggested by the results of the following experiment in mice. Six 21-day-old female albino mice (litter mates) were hysterectomized through a small supra-pubic incision. Both cervices were carefully removed. No intra-abdominal clamping or tying was done save for a single black silk ligature placed about the top of the vaginal stump. The incision was closed with a single skin clip. Four female mice from another litter of the same age were used as controls. At 22 days of age each mouse was injected subcutaneously with 0·5 c.c. (5 I.U.) of an aqueous solution of chorionic gonadotropin. The solution was prepared from the international standard preparation of this hormone, to contain 1·0 mgm. per c.c.

The animals were sacrificed 96 hours after injection. Vaginal introitus had been established in all the controls and all but one of the hysterectomized animals. Œstrous and metœstrous smears were present in the controls and mucus and leukocytes only were seen in the smears from the hysterectomized mice the vaginæ of which were open. The ovaries from three of the four control animals contained corpora lutea while those from the hysterectomized animals contained none.

The experiment was repeated using ten more mice (five controls and five hysterectomized) of the same age. The amount of chorionic gonadotropin was doubled, that is, each mouse received 0·5 c.c. of an aqueous solution containing 2 mgm. of the standard hormone per c.c., or 10 I.U. The animals were sacrificed 96 hours after injection. Again, vaginal introitus had been established in all the controls and all but one of the hysterectomized mice. The controls exhibited œstrous and diœstrous vaginal smears and marked uterine growth and circulatory congestion. The vaginal smear from one of the hysterectomized animals was œstrous but the others contained leukocytes. Corpora lutea were present in all the ovaries of the controls but none was found in the ovaries of the hysterectomized animals. The ovaries of the hysterectomized mouse exhibiting full œstrus were enclosed in hæmorrhagic capsules. The ovarian tissue itself, however, appeared quite normal and contained no corpora lutea upon histological examination. With this exception none of the ovaries of the hysterectomized mice in either group showed any evidence of surgical trauma or degeneration.

The mouse unit of chorionic gonadotropin in this laboratory has been found to be approximately equivalent to 4 I.U. The experiment described above was carried out according to the bio-assay procedure by which our mouse unit of chorionic gonadotropin was ascertained: namely, a single subcutaneous injection of 0·5 c.c. of aqueous solution. The results of the experiment suggest that the absence of the uterus decreases the gonadotropic effect of threshold doses of chorionic gonadotropin on the ovaries of 20-day-old mice.

This study was made possible by the Christine Breon Fund for Medical Research.

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[1] Mishell, D. R., and Molytoff, L., *Endocrinology*, 28, 436 (1941).
[2] Marx, R., Catchpole, H. R., and McKennon, B. J., *Surg. Gynec. and Obstet.*, 63, 170 (1936).

Evolution of the Fleece of the Sheep

RECENT comparative studies of fibre-type arrays, mostly in the New Zealand Romney, have thrown new light on the probable course of evolution in the coat of the sheep from wild type to the most 'improved' domesticated fleece. Fibre type arrays[1] are distinguished essentially by differences attributed to the lesser or greater power of the pre-natal check. The effect of this check stands out most clearly when, as in Ravine and Valley arrays, among fibres beginning their development before birth, it causes some starting to grow earlier to be finer than some starting to grow later. Fibre-type array is strongly inherited[2] and this fact gives confidence in the soundness of this new approach to the evolution of the fleece.

Although I am now finding great interest in a study of the coat of wild lambs, the present communication deals with more advanced stages in the evolution of the fleece. The course of evolution has run, I am satisfied, from Plateau, through Saddle and Ravine, to Valley and Plain. Within a given fibre-type array there are mostly quantitative differences which make it possible to arrange arrays in a

graded series according to their 'toughness', and between the several arrays, which differ from one another qualitatively rather than quantitatively, there are links.

The series of arrays named reveal the increasing power of the pre-natal check of Dry, which is responsible for the fineness of fine sickle-fibres and checked curly-tip fibres. This check it seems convenient to call the 'head check' to distinguish it from a check occurring a little later, recognized by Dr. Nancy Galpin[3], which may be called the 'tail check'. 'Tail' has reference, of course, not to the caudal appendage of the animal, but to fibres starting to grow comparatively late. These fibres are well removed in position in the array from pre-curly-tip fibres, and so constitute the tail of the array.

Fibre types are classified in three groups, namely, pre-curly-tip, curly-tip and post-curly-tip. The first comprises halo-hairs, super-sickle-fibres and sickle-fibres; the second hairy-tip-curly-tip fibres and ordinary curly-tip fibres; the last histerotrichs. The first two groups constitute the birth-coat; the first fibres of the third pierce the skin about the time of birth. From the evidence in hand it is concluded that halo-hairs in the pre-curly-tip group, hairy-tip-curly-tip fibres in the curly-tip group, and histerotrichs in the post-curly-tip group are phylogenetically the oldest fibre types. In the course of evolution halo-hairs have undergone a series of changes, becoming transformed step by step to super-sickle-fibres[2] of, successively, the three types, A, A^1 and B, to chalky sickle-fibres, and eventually to fine sickle-fibres. The table serves to illustrate what has happened. Apart from an exceptional situation, to be mentioned later, the percentage of pre-curly-tip fibres (computed on total fibres in an array) is similar in all arrays.

RELATIVE ABUNDANCE OF THE SEVERAL FIBRE-TYPES IN DIFFERENT ARRAYS.

(Based on six regions of seventeen lambs. Means expressed as percentage of total pre-curly-tip group. The last two columns computed on total sickle-fibres.)

Array	Halo-hairs %	Super-sickle a %	Super-sickle a¹ %	Super-sickle b %	Sickles %	Sickles: Chalky %	Sickles: Fine %
Plateau	31·7	41·5	11·1	15·0	0·7	100·0	0·0
Saddle	0·2	4·0	8·3	26·5	61·0	100·0	0·0
Ravine	0·9	1·9	4·0	14·4	78·8	57·9	42·1
Valley	0·2	0·5	1·2	13·0	85·1	10·6	89·7
Plain	0·0	0·0	0·0	0·0	100·0	0·0	100·0

As evolution has proceeded the centre of gravity in the pre-curly-tip group has been shifted from halo-hairs and super-sickle A in Plateau to fine sickle-fibres in Plain. Hairy-tip-curly-tip fibres are abundant in Plateau, rare in other arrays, and I would elevate them to a position of high ancestral importance. Indeed, in the curly-tip group of non-Plateau I conclude that four-fifths of the curly-tip fibres have evolved from hairy-tip-curly-tip fibres.

In the evolution of histerotrichs I would emphasize what I believe to be the 'promotion' of the earliest histerotrichs to become the latest curly-tip fibres. In Plateau about half of the fibres are histerotrichs, in Valley and Plain about one fifth. The trend of evolution is seen to be towards the goal of a coat composed entirely of curly-tip fibres. In very 'improved' fleeces of Plain array the reduction of both pre- and post-curly-tip groups is very marked indeed. In a plain array, it is to be noted, the effects of the head and tail checks overlap. In arrays lacking hairy pre-curly-tip fibres, with all the fibres of this group fine sickle-fibres, the numbers of the pre-curly-tip fibres may be reduced, and quite frequently in Wensleydale arrays[4] and once in a Romney array, no sickle-fibres at all have been found. To my thinking, the pre-curly-tip fibres have undergone, not loss, but extreme change.

The covering of the wild sheep has long been recognized as consisting of a hairy outer coat and an inner coat that is fine and not hairy. In Plateau I take the outer coat to be represented by the pre-curly-tip group and many fibres of the curly-tip group. In the course of evolution the trend has been for both outer coat fibres and inner coat fibres to become non-hairy curly-tip fibres. It may be added that there is a correlation between the percentage of hairiness determined by the medullometer (McMahon[5]) and the array. The contrast is most marked between extreme arrays, Plateau being grossly hairy, whereas Plain shows scarcely any trace of hairiness. The same relation holds for the average abundance of secondary kemp.

In the Romney the Plateau array is common on the britch, but N-type having the Plateau array on all or most of the main area of the body is rare, save in Dry's experimental stocks. The fleece characterization of N-type—whatever be the genetic basis—is atavistic, and links the Romney with some other breeds of sheep situated lower on the ladder of evolution, notably Blackface Mountain sheep. On the other hand, Valley and Plain arrays were found not only in the Romney but also in the Ryeland, Southdown[3], Wensleydale and Merino[4]. Thus we deal with a transitional series of arrays, from Plateau through Saddle and Ravine to Valley and Plain. In this series we trace the path of the evolution of the fleece. The genetic basis of these evolutionary changes probably resides in small mutations.

This note is based on a thesis recently presented to the University of New Zealand. It is hoped shortly to publish a full account of this investigation.

H. GOOT.

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Palmerston North,
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June 5.

[1] *N.Z. J. Agric.*, 48, 6 (1934).
[2] *N.Z. J. Sci. Tech.*, 22, 4A (1940).
[3] *Emp. J. Exp. Agric.*, 4 (1936).
[4] Sutherland, J. A., Unpublished thesis, University of New Zealand (1939).
[5] *J. Text.Inst.*, 28, 12 (1937).

Aphid Transmission of Strawberry Viruses

BRITISH workers with strawberry viruses have so far failed to obtain transmission of Fragaria virus 1 (yellow edge) or Fragaria virus 2 (crinkle) by aphides other than the 'delicate strawberry aphis', *Pentatrichopus* (*Capitophorus*) *fragariæ* Theob., a species possibly identical with the American vector *Capitophorus fragæfolii* Ckll.

In experiments at this College the following species of aphides, recorded on strawberries in North Wales, consistently failed to transmit any virus from severely diseased plants of the variety Royal Sovereign: *Macrosiphum solanifolii* Ashm., *Aula-*

corthum solani Kalt (= *Myzus pseudosolani* Theob.), *Myzus persicæ* Sulz., *Myzus circumflexus* Buckt. (a single specimen only—possibly a stray from a glass-house—was taken on strawberry), *Myzus ornatus* Laing (tested only in the case of crinkle).

Other aphides tested as possible vectors of crinkle included *Pentatrichopus potentillæ* Walk. and *Pentatrichopus tetrarhodus* Walk. All attempts to achieve transmission by means of the former species were unsuccessful, but transmission from Royal Sovereign to *Fragaria vesca* L. was obtained with *P. tetrarhodus* both in 1940 and 1941, the resultant symptoms being indistinguishable from those induced by means of *P. fragariæ*. This discovery is of academic interest in that it suggests a specificity of relationship between strawberry viruses and the genus Pentatrichopus. The host-ranges of British members of this genus were described in a recent paper by Thomas and Jacob[1], who stated that *P. potentillæ* appears to occur only on *Potentilla anserina* L., and fails to survive on strawberries; while *P. tetrarhodus*, although capable of living for a rather longer period on strawberries under glass, occurs naturally only on species of Rosa. Further work is contemplated to discover if *P. potentillæ* is invariably a non-vector of crinkle and, if so, whether this is due to some metabolic cause operating within the insect or to the feeble extent to which the species is able to feed on strawberry.

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Oct. 15.

[1] Thomas, I., and Jacob, F. H., *Ann. App. Biol.*, **27**, 234 (1940).

Frequency of Occurrence of Wars and other Fatal Quarrels

IN order to investigate the causes of wars by counting occurrences, let the magnitude of any war be defined to be the logarithm, to the base ten, of the number of persons who died because of that quarrel. This definition has the advantage that it applies, not only to what are ordinarily called wars, but also to all kinds of fatal quarrels, including insurrections, frontier incidents, riots and murders.

The numbers of wars of various magnitudes, which ended from 1820 to 1929 A.D. inclusive, have been counted, after laborious search in works on history. The number of murders is an estimate from the statistics of crime. Between the wars and the murders, in the range between magnitudes 2·5 and 0·5, there were certainly many fatal quarrels; but statistics of them are scanty, presumably because such incidents are mostly too small to be history and too large to be crime. The results are:

Ends of range of magnitude	$7\pm\frac{1}{2}$	$6\pm\frac{1}{2}$	$5\pm\frac{1}{2}$	$4\pm\frac{1}{2}$	· · · ·	$0\pm\frac{1}{2}$
Observed number of fatal quarrels	1	3	16	62	· · · ·	10^7

It is seen that the numbers of wars in successive equal ranges of magnitude are nearly in agreement with the geometrical progression 1, 4, 16, 64; but that when this progression is continued, it gives 16,384 for the number of murders instead of the observed 10^7.

These remarkable relations call for explanation. A full account of this and cognate matters is nearly ready for publication elsewhere.

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Science in the U.S.S.R.

IN NATURE of October 25, p. 497, M. Maisky's statement that "there is no place in the U.S.S.R. for pure science" is described as "rather unfortunate". In 1646 Robert Boyle stated that he was studying natural philosophy "according to the principles of our new philosophical college, that values no knowledge, but as it hath a tendency to use". I think the two statements are equivalent. Sprat, the first historian of the Royal Society, into which the Invisible College metamorphosed, went even farther towards the theory held in the Soviet Union, in postulating a class basis for science. "Their mechanics and artificers (for whom the true natural philosophy should be principally intended)", he wrote, "were so far from being assisted by those abstruse doctrines, that perhaps scarce any one of these professions, and trades, has well understood Aristotle's *Principles of Bodies*, from his own time down to ours." I think these quotations will show that the Soviet practice and theory on this important matter, whether or not we approve of them, are in the great tradition of British science.

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TAKING the above quotations from two British men of science of three hundred years ago on their face value, one must allow that the Soviet practice and theory are compatible with their views, though it is possible that the *general* views of Boyle and of Sprat may be considered to be not quite so dogmatic as these single quotations would imply. In any event, we cannot agree that the views of these two men alone thus put the present-day Soviet practice and theory in the great tradition of British Science.

More important still, the main point at issue, surely, is the attitude of the general body of *present-day* British men of science. It is to be hoped that the time will never come when it can truthfully be said that there is no place in Great Britain for pure science. Prof. Haldane should, we think, have concluded the sentence in quoting from NATURE, which ran as follows: "since we do not believe that pure science has been altogether taboo in the U.S.S.R."

There seems to be a dangerous tendency to make too prominent a distinction between pure and applied science, for it may easily involve the risk that the protagonists for a *planned* scientific policy will be accused of wishing to oust pure science altogether. This is far from the truth. Scientific planning involves pure as well as applied science, especially when taking the long view; and that is why we consider M. Maisky's statement unfortunate, because we have no doubt that though there may be more *conscious* planning of science in the U.S.S.R., that country has not expunged pure science from its programmes merely because it is pure.—EDITORS.

CEREALS AS FOOD

THE fourth of the series of symposia on the nation's food arranged by the Society of Chemical Industry took place on October 29. The subject was "Cereals as Food".

The first paper, contributed by R. G. Booth, R. H. Carter, C. R. Jones and T. Moran, dealt with the "Chemistry of Wheat and Wheat Products". It consisted of a review of the literature, supplemented by estimations carried out by the authors on analyses of the wheat 'berry' as a whole and its separate constituents. The paper showed the wide variations that exist, depending upon the variety and cultural conditions of the wheat, but it is equally clear that many of the figures quoted in the literature are based on unsatisfactory analytical methods. Figures were given for the phytin and vitamin contents of wheat and flours of different extraction, and a large section of the paper dealt with the separation of the different fractions of wheat during milling.

This led logically to an analysis of high-extraction flours including National Wheatmeal. According to the authors, wheatmeal can be classified as rational or irrational meals depending upon how far the proportions of the different offal stocks in the meal are equal to, or are in excess of, the amounts present in whole wheat. National Wheatmeal is a rational meal, but the authors showed that, provided white flour continues to be milled, an 85 per cent extraction meal superior to National Wheatmeal could be produced. This is clearly a question to be considered after the War.

A. L. Bacharach and D. W. Kent-Jones followed with a paper on "The Nutrient Analysis of Bread". They first pointed out that flour as bread alone contributes something like 20 per cent of our total intake of calories and 20 per cent of our intake of proteins; in all forms, including cakes, puddings, etc., these figures are increased to about 35 per cent. Incidentally, they showed that, in terms of calories and protein combined, bread is far and away the cheapest foodstuff. The authors then considered the effects of phytin in immobilizing calcium, and attempted a calculation of the available calcium in white flour and National Wheatmeal, on the basis that the salts formed are either the tri- or hexa-calcium phytates. They pointed out, however, that this at best could only be a rough guide because of the complicating effects of magnesium on the precipitation of phytate. Their figures gave a quantitative justification for the 7 oz. and 14 oz. of calcium carbonate per sack of white flour and National Wheatmeal that the Medical Research Council recently recommended. It should be pointed out, however, that recent work has shown that most of the phytin can be hydrolysed by suitable conditions of baking, so that the higher amount for National Wheatmeal may not be necessary.

The authors also outlined the proposals in the United States for the fortification of white flour which would make B_1, nicotinic acid, riboflavin and iron compulsory, with calcium and vitamin D optional. The maximum amounts proposed for the first four factors would make the flour the equivalent of wholemeal bread. Mr. Bacharach and Dr. Kent-Jones suggested that the fortification of white flour should be extended to include iron as well as B_1 and calcium.

H. C. Moir had a difficult task in his paper on "The Composition and Nutritive Value of Oats and Oatmeal". The literature on this particular cereal is scattered and scanty, but the author succeeded in assembling data which should be of great value as a source of reference; there would, however, appear to be many anomalies; for example, the fact that the contents of tryptophase, lysine and histidine are greater in flaked oats as against whole oats. Mr. Moir emphasized that in view of the high protein, fat, iron and B_1 of oats, it is clearly an important human food. In the preparation of porridge the loss of B_1 is only 5–10 per cent, but with oatcakes the loss is 35 per cent, due presumably to the added sodium bicarbonate reducing the acidity. The question of phytin in oatmeal was also discussed, and it was pointed out that when porridge is properly prepared, that is, by soaking overnight, the inorganic phosphorus would be increased. The suggestion that oatmeal aggravates gout and rheumatic conditions was summarily dismissed.

The final paper, by W. P. Ford, "The Composition and Nutritive Value of Cereals other than Wheat and Oats", dealt with the remaining cereals—maize, rice, rye and barley. Maize contains 8–10 per cent of germ with a fat content in the germ of about 30 per cent. It is deficient in calcium, magnesium, iron and phosphorus as compared with wheat, but the protein contents of whole-maize and wheat are apparently equal.

The author described the changes in vitamin B_1 consequent upon de-husking, winnowing and polishing rice and showed why, except as a source of easily digestible carbohydrate, polished rice is the least valuable of all the cereals. He also mentioned the interesting fact that in the middle of the eighteenth century up to 42 per cent of rye was included in bread flour in Great Britain. German rye often contains 20–30 per cent of white flour, while American bread of the same name never contains less than 66 per cent.

In the discussion that followed, Dr. Green emphasized the importance, in cereal research, particularly in its nutritional aspects, of using material of known history and origin. This was supported by Mr. Bacharach, who, after pointing out the wide variations in individual chemical characteristics found in cereals, suggested that after the War at least, an organized attack should be made on all food stuffs, in order to collect precise and comprehensive analytical data.

Mr. Bacharach also stressed the need for further work on the availability of the different elements including calcium and iron, and went so far as to suggest that instead of protein figures for foods the individual amino-acids might be estimated.

In the papers and the discussion two points stood out: (1) the frequent references made to the analytical tables of McCance and Widdowson; (2) the unanimous view that much work has still to be carried out before we have anything like a factual picture of the chemistry of cereals, even wheat. Perhaps for this reason the excursions into the nutritional field were generally extremely tentative. The chemist does not dogmatize without the facts. This alone is a guarantee of the value of these discussions on the nation's food.

MODERN CAST IRON

FEW metallurgical products have shown such a marked improvement in quality during the last two decades as have the cast irons. So rapid has this advance been, that few, except those in immediate contact with the industry, can have kept abreast of the work done; and the engineer user has perforce lagged behind in his knowledge of the new materials thus placed at his disposal. It was presumably in appreciation of this fact that the Institution of Mechanical Engineers formed a Research Committee on High Duty Cast Irons for General Engineering Purposes, the first report of which was published in 1938. This was concerned with a general outline of the development of both the "high-duty" irons used on account of their enhanced strength, and of the special-duty irons employed in the main as a result of their possession of unusual physical or chemical properties.

On the outbreak of war, the attentions of the Committee were necessarily somewhat diverted to those matters within their province which would most immediately assist in the national effort. Of these, one of the most important was the question of making the fullest use of Great Britain's own iron ores, the most abundant of which are phosphoric. From these ores, irons containing up to around 1·5 per cent are produced, and the second report of the Committee, recently published by the Institution, is an excellent account, prepared by J. G. Pearce, director of the British Cast Iron Research Association, of the phosphoric grey irons used by the foundryman and engineer. The mechanical properties of these materials, both at ordinary and at elevated temperatures, are discussed, and curves are provided showing what type of properties may be expected from an iron of given carbon, silicon and phosphorus contents.

A third report, also prepared by Mr. Pearce, is devoted to a consideration of the newest forms of alloyed irons. As a consequence of the War, a demand has arisen among engineers for fuller information regarding the special irons which are being used, both for their own sakes and as substitutes for other materials in urgent demand.

This report is divided into separate sections dealing respectively with the austenitic and the martensitic irons, and well fulfils its purpose. The former type of iron bears to ordinary ones a relationship not dissimilar from that borne by the stainless steels to plain carbon material. Their characteristic properties include softness, ductility, and high resistance to wear, erosion, corrosion and heat. In addition, they are non-magnetic, of high electrical resistance and thermal expansion and low thermal conductivity. These materials have passed far beyond the field of research, and an appendix contains a list of many scores of examples of typical applications of such irons in actual engineering practice.

Where resistance to wear or erosion is the factor of prime importance, the martensitic irons, on account of their great hardness, find many important uses, some sixty or seventy specific examples of which are cited.

These reports, of which others are promised, contain select but adequate references to original sources of information, and should be of great value to makers and users alike. The author, the Committee and the Institution, in preparing and publishing this information, are performing a service of immediate national importance. F. C. T.

FORTHCOMING EVENTS

MONDAY, NOVEMBER 17

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Miss L. E. Cheesman: "The Border Mountains and Torricelli Range of Northern New Guinea".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Curtin Cosbie: "Brewing, the Story of a National Industry" 1: Brewing Materials. (Cantor Lectures, I).

WEDNESDAY, NOVEMBER 19

SOCIETY OF GLASS TECHNOLOGY (at Elmfield, Northumberland Road, Sheffield, 10). Twenty-fifth Anniversary Meeting. 10 a.m.—Symposium on Glass Furnace Problems, I. 2.35 p.m.—Symposium on Glass Furnace Problems, II.

THURSDAY, NOVEMBER 20

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. T. Astbury, F.R.S.: "X-Rays and the Stoichiochemistry of the Proteins".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir James Jeans, O.M., F.R.S.: "Is there Life on Other Worlds ?"

FRIDAY, NOVEMBER 21

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. W. T. Halcrow: "A Century of Tunnelling" (Thomas Hawksley Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DIRECTOR OF EDUCATION—The Town Clerk and Clerk to the Local Education Authority, Town Hall, Brighouse, Yorks. (endorsed 'Director of Education') (November 19).

BOROUGH ANALYST—The Town Clerk, Town Hall, Burnley (November 24).

SENIOR ASSISTANT to the Principal of the Barrow-in-Furness Technical College and Junior Technical School (will be required to take Evening Classes in MECHANICAL ENGINEERING)—The Director of Education, Town Hall, Barrow-in-Furness (November 29).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Hull Bulletins of Marine Ecology. Vol. 1, Nos. 4 and 5: Ecological Investigations with the Continuous Plankton Recorder—The Copepoda of the Southern North Sea, 1932–37, by K. M. Rae and J. H. Fraser; Ecological Relations between the Herring and the Plankton off the North-East Coast of England, by C. Cheng. Pp. 171–254+plates 65–125. 10*s*. Vol. 2, Nos. 7 and 8: Continuous Plankton Records—General Introduction to the 1938–39 Survey, by Dr. A. C. Hardy; Continuous Plankton Records—Phytoplankton in the North Sea, 1938–39, Part 1: Diatoms, by C. E. Lucas (assisted by W. Macnae). Pp. 46+plates 1–38. 8*s*. (Hull: University College.) [2210

Other Countries

U.S. Office of Education: Federal Security Agency. Vocational Division, Monograph No. 22: Farm-Family Living; contributing to Satisfying Farm-Family Living through Cooperative Educational Programs in Vocational Agriculture and Home Economics. Pp. iii+12. (Washington, D.C.: Government Printing Office.) 5 cents. [2010

National Research Council of Canada. N.R.C. No. 1011: Abstracts on Storage of Grain. By Muriel E. Whalley. Pp. 180. (Ottawa: National Research Council of Canada.) 3 dollars. [2210

New Zealand: State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1941. Pp. 50. (Wellington: Government Printer.) 1*s*. 3*d*. [2210

New Zealand. Fifteenth Annual Report of the Department of Scientific and Industrial Research. Pp. 92. (Wellington: Government Printer.) 9*d*. [2210

Report on the Department of Agriculture, St. Lucia, 1940. Pp. ii+12. (St. Lucia: Government Printing Office.) 6*d*. [2210

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NATURE

SATURDAY
Nov. 22, 1941

THE CIVIL SERVICE IN GOVERNMENT

BEHIND the less restrained and sometimes unfair criticism which has been levelled at the Civil Service as the War has continued, there has lain a vague, unformulated feeling that the Civil Service as a whole is slightly out of touch with the times, and neither in calibre nor technique quite so competent to handle the tasks with which it is confronted as was the Civil Service of a generation ago.

It is the great merit of a recent broadsheet, "The Machinery of Government", issued by Political and Economic Planning, that it brings such uneasiness into the light of day, probes its causes, and, setting the Civil Service in its proper perspective in relation to the task of government, makes constructive proposals for removal of many of the defects revealed.

In the first place, as the broadsheet points out, there is no peculiar 'democratic virtue' in incompetent administration; modern government is increasingly a matter of determining the right priorities in the broadest sense, of educating public opinion to those priorities, and of adjusting organization and methods to give them the fullest and most immediate effect. The failure of our executive machinery of government to plan ahead, its failure continuously to adjust its working structure and technique to the problems with which it is called upon to deal, its continued domination by financial and accounting aspects, its neglect of scientific and technical advances and its timidity in accepting responsibility, all flow from a failure to renounce the old conception of government as a regulatory, policing and taxing mechanism ; and openly to adopt the conception of government as the nation's common instrument for expanding its social and economic welfare in all those spheres where individuals or private associations cannot achieve equally effective results.

Although some improvement is being effected through the creation of new organizations and the elimination of weak spots, apart from the important exception of Mr. Eden's proposed reforms at the Foreign Office and in the Diplomatic Service, there has been little sign of the radical change of outlook involved in this new conception of government. Moreover, in reviewing the complex machinery of central government, as the broadsheet points out, it is important to consider Parliament, Ministers and the Civil Service, not in isolation but in their mutual actions and reactions. The Minister, for example, is to a very great degree dependent on the advice of the full-time professional officers of his Department for the policies which he submits to his colleagues in the Cabinet. In the execution of these policies

he can do little to secure more vigorous or effective action if the machine of which he is temporarily in charge is rusty or otherwise defective. No individual Civil Servant should be blamed for the consequences where advice he has given has been ignored by the Minister or by the Cabinet, but the Civil Service as a body must bear a fair share of the responsibility if the techniques for obtaining information and for shaping and presenting policy are such that too high a proportion of decisions prove to be ill-advised. The Civil Service, as a body, given the knowledge and the will to do so, is in a position to alter those techniques: generally speaking, the individual Minister is not.

The P E P broadsheet, leaving for a later statement the political and ministerial elements in the problem, discusses the main weaknesses of the Civil Service and how they might be corrected. It carries into constructive detail the ideas to some extent outlined by Dr. W. A. Robson in his introductory essay in "The British Civil Servant" some four years ago, and forms an admirable complement to the study of the growth of the British Civil Service, 1780–1939, by Emmeline W. Cohen*. There is indeed no simple or magic remedy. The solution lies partly in the change in the basic attitude to the task already emphasized, partly in some changes and developments of organization, partly in the modernization of methods and the use of available resources and techniques which have hitherto been neglected. Behind it all lies the problem of choosing the right men and using their abilities to the full.

It will readily be conceded that in present circumstances it would be impossible and highly dangerous to attempt a complete reorganization of the Civil Service. Modification of the recruitment, training and development of a great professional body is a long-period undertaking, which can only take effect over several decades. Fortunately, however, the measures which are immediately possible do not appear to conflict with the long-range measures required to equip the country to face the tasks which will meet it at the end of the War.

The analysis of the Civil Service in this broadsheet points once more to the weakness of the Service in knowledge of social and natural science, and in grasp of scientific method or technique. Training is in general political and administrative rather than executive. There is little knowledge of the new techniques of large-scale organization and management which have been developed in the last forty years, and an imperfect appreciation of the fact-finding method of approach to problems of administration on which these techniques are based. Even less than in industry the distinction of staff from line functions is not properly recognized, and there is no conception of holding any of the strength in reserve for emergencies—a criticism which equally applies to a large part of industry.

*The Growth of the British Civil Service, 1780-1939. By Emmeline W. Cohen. Pp. 222. (London: George Allen and Unwin, Ltd., 1941.) 10s. 6d. net.

These severe criticisms find support in a recent important study of the advisory bodies, on which the Haldane Report laid such stress; indeed the analysis reiterates not a few of the criticisms contained in that Machinery of Government Committee's report of twenty-three years ago. The emphasis laid there on the need for further provision for the continuous acquisition of knowledge and the prosecution of research, and on the desirability of establishment departments keeping themselves acquainted with what is being done in the business world are at once recalled by comments in the present broadsheet.

At the same time, it should be remembered that the adoption of a fact-finding technique by the Civil Service has sometimes been checked or discouraged rather than welcomed. The rebuke administered in the *Times Educational Supplement* to the Board of Education regarding a memorandum compiled by officers of the Board as a basis for discussion on the nation's next moves in educational planning is a recent example. If responsible opinion is to stigmatize such initiative as a grave constitutional novelty it is unlikely, to say the least, that the type of administrator now so urgently needed will be forthcoming.

The truth is that the weaknesses of the Civil Service are due, not to incapacity, but to a group of inhibitions and an absolute conception of government, which must be overthrown by the force of public opinion. That is the first step to securing that the Civil Service recognizes its function in safeguarding and developing the collective inheritance and the social and economic welfare of the nation, as well as that of preserving and assisting to enrich the individual liberties of its citizens. Only public opinion can secure the change from an agenda of public business, determined by external pressures, to one determined by the needs and facts of the situation, based upon thorough intelligence, careful forecasting and continuous analysis of the problems affecting the particular branch of government, and of the best ways of meeting them within the limits of general policy decided by Ministers and approved by Parliament. That change involves a radical alteration in the criteria applied in public administration—a shift in emphasis away from reliance on precedent, consistency and the avoidance of trouble from minority groups, towards action based on a thorough survey of the situation, a sound judgment of its implications and a clear perception of both in the minds of all the officers and departments concerned.

The first main conclusion of the P E P survey, then, is that this new conception of the function of government, with all that it implies for the Civil Service in changes in outlook, organization and methods, and in its relation to Ministers, should be fully and frankly faced. This conception was in fact equally implicit at the recent Conference on Science and World Order, not merely in the session devoted specifically to science and government, but also in those devoted to the relation of science to human needs and to post-war relief. The speeches of Mr. Eden and Mr. Morrison in connexion with the Conference indicate that the Government in Great Britain is now alive to these implications, and scientific workers may well be encouraged by the Conference to further efforts towards the formation of the public opinion essential for Parliamentary support.

From this it follows that the Cabinet secretariat must somehow be permanently strengthened in powers and personnel in co-operation with the departments concerned, to exercise the three functions of planning, personnel management and budgetary control, which are of decisive importance in determining the scope and efficiency of the machinery of government. This involves keeping continuously under review the main strategic conditions affecting government in the economic and social fields, presenting and examining the possible alternative courses, and putting them up for decision in order to elicit from Ministers the necessary directives on policy and priorities affecting groups of departments. The organization would also be responsible for working out with departmental officers the application of such directives to particular circumstances, for seeing that action is taken and for recording and circulating suitably digested information regarding it. Such an organization would not only supply the machinery for central planning and co-ordination; it would also supply the equally important mechanism for following up and seeing that approved policies are effectively and promptly put into operation.

The same fundamental conclusion regarding the Treasury is reached by the P E P broadsheet as in the Haldane Report. The recommendation that this should become purely the Department of Public Finance and the Budget, with a modernized outlook and methods, is the reflexion of criticism of the traditional attitude of antagonism between the Treasury and other departments. It is a reminder of the comment in the Haldane Report that the obligation of spending departments to formulate a full and reasoned statement of their proposals places upon the Treasury a corresponding obligation not to assume a negative attitude in the first instance towards suggestions for improving the quality of a service or the efficiency of the staff which administers it.

In the same train of thought follows the recommendation that the management and control of personnel matters should be delivered from finance, but the P E P broadsheet goes far beyond the Haldane Committee in recommending the formation of a central personnel office by transfer to a reconstituted Civil Service Commission with a suitably qualified membership, not limited to Civil Servants, of the establishment and office organization function of the Treasury. In political matters this Commission should be directly responsible to the Prime Minister. This step should be taken immediately, even if some of its long-term implications cannot be worked out until after the War.

This and other recommendations, like those for the establishment of a staff college for the higher training of men and women destined for high administrative or executive responsibilities, and the introduction into each department of the organization and techniques necessary for effective forecasting and planning ahead, or again the modification of methods of recruitment, training and grading so as to bring the ablest men rapidly to the top and eliminate the waste of good material, are in harmony with modern scientific administration and the best practice of large-scale industry. So, too, is the suggestion that the scope normally assigned to scientific workers and to technical experts should be enlarged. The broadsheet in fact reflects the essential criticism contained in many recent discussions of the Civil Service.

There can be no doubt that this searching analysis goes to the root of the troubles which have prompted much recent criticism of the Civil Service, fair or unfair. If it seems disappointing to find so little effect has been given to authoritative recommendations formulated more than two decades ago, Emmeline Cohen's book provides an admirable corrective. For all its weaknesses, the British Civil Service is a growing service, adapting itself continuously to changed conditions. The rate of change may lag behind what is desirable, but that can be accelerated by the pressure of public opinion. The suggestions in the P E P broadsheet would go far to secure the greater flexibility required within the Service, the increased mobility between it and the external world, the new conception of the task confronting the Service and the dissemination throughout the Service of a new outlook and new methods. What is required to secure the adoption of such methods and the placing of new men in key positions is the steady pressure of public opinion, in the formation of which scientific workers themselves have an important part to play.

PSYCHOLOGY OF WAR AND CRIME

War and Crime

By Hermann Mannheim. Pp. ix+208. (London: Watts and Co., Ltd., 1941.) 10*s*. 6*d*. net.

The Education of Exceptional Children

Its Challenge to Teachers, Parents and Laymen. By Prof. Arch. O. Heck. (McGraw-Hill Series in Education.) Pp. xviii+536. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 26*s*.

Genius in the Making

By Herbert A. Carroll. (McGraw-Hill Series in Education.) Pp. xi+307. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 19*s*.

IN his latest book, Dr. Mannheim has amplified the course of lectures which he was recently invited to give at the London School of Economics on the relations between war and crime. Formerly professor of criminal law in Berlin and a judge in the German Court of Criminal Appeal, later Leon research fellow and lecturer in criminology in the University of London, he is almost uniquely equipped to discuss the problems he has taken up.

War, as is well known, commonly increases the frequency of certain types of crime, but Dr. Mannheim shows that it may also diminish the frequency of other types, thus in some measure acting as a substitute. This in turn suggests that, from a psychological point of view, war may be regarded as itself a form of crime. He is thus led to examine the various analogies between an unjust war as an anti-social action committed by nations, and an illegal offence as an anti-social action committed by an individual.

Writers who have discussed the origins of war or crime have often advanced, seemingly without recognizing the parallel, much the same causal theories. Lombroso and his followers have put forward a biological explanation of crime; similarly Steinmetz and others have put forward a biological explanation of war, attributing it to the innate aggressiveness possessed by the more vigorous nations that have been brought to the fore in the struggle for survival. Other criminologists have argued that, not heredity but environment, not inborn degeneracy but external poverty, is the main factor in crime; similarly sociologists have argued that the main causes of war are not biological but economic. Finally, psychiatrists have sought to explain both war and crime in terms of whatever psycho-analytic doctrine happened to be in fashion at the moment: the followers of Freud attribute them to the social repression of the common human instincts; in their view, the Œdipus complex, with the love-hatred situations, the consequent defence-mechanisms, and the curious symbolic processes that it involves, will account for the behaviour alike of belligerent nations and of the individual offender; Adler's disciples prefer to trace both war and crime to an inferiority complex, leading, in nations as in individuals, to over-compensation and a morbid desire for power.

Dr. Mannheim has no difficulty in criticizing these one-sided and somewhat speculative theories. As he points out, they are the views of amateurs who have strayed into psychology from other fields of work rather than conclusions reached by scientific psychologists themselves. Those who have investigated the causes of delinquency at first hand have almost unanimously agreed that crime in the individual is due "not to a single universal cause, but to a multiplicity of converging factors, the nature of the factors and of their varying combinations differing widely from one individual to another". In much the same way, Dr. Mannheim concludes that, in war as in crime, not one cause but a number of causes are operative, the causes being different in different cases. From the numerous analogies in respect of causation he draws a practical corollary in regard to remedies: the psychological methods that have proved so successful in the treatment of crime might profitably be adopted to prevent war and to secure peace.

The inferences, as Dr. Mannheim develops them, prove most suggestive. But one principle he perhaps does not sufficiently stress. Recent investigations into the after-careers of criminals treated at psychological clinics and elsewhere, indicate that by far the most hopeful method of reducing crime is to deal, not with the hardened adult, but with the younger generation: the education of the young is at once easier and more effective than the re-education of the old. Moreover, to be successful, methods of education must be adapted more closely to the needs of the individual. Dr. Mannheim himself has shown that it is the exceptional individuals—the highly intelligent, the highly excitable, the relatively phlegmatic and most of all the relatively dull—who most frequently succumb to crime. This suggests that one of the most important items in post-war reconstruction should be an improvement of educational methods, in catering more particularly for the exceptional child.

Dr. Heck's book provides an admirable survey of this problem as it arises in the United States. He describes in turn the special needs of those who are handicapped socially, physically and mentally, and of those who are intellectually gifted; and his chapters summarize in considerable detail the existing provision for these children in the cities and States of North America, and reviews the basic principles that emerge from psychological inquiries on the various questions involved.

In Great Britain a long series of psychological researches has been carried out on the mental characteristics and the educational requirements of the mentally subnormal; but little has been done in regard to the intellectually gifted. We have a scholarship system; and the efficiency of scholarship examinations has been subjected to critical investigation. But few British psychologists have attempted a systematic study of the gifted child as such.

Prof. Carroll's book brings together in compact and readable form the results of the work carried out upon this subject, chiefly in the United States. Many of the conclusions that he cites as fairly well established are still insufficiently appreciated in Great Britain. Prof. Carroll shows, for example, that high ability is nearly always recognizable in childhood: the exceptions so commonly cited are not enough to invalidate the rule. At the same time, eminence in later life is not determined by intelligence alone. Among the intrinsic factors, he lays most stress on temperamental qualities: "ambition" (in the sense of a determination to become eminent), "drive" (in the sense of emotional energy), "singleness of purpose", "fluency" (especially in speaking or writing), and finally emotional and moral stability. Physical factors, such as appearance, size and health, often play a contributory and sometimes an undue part. The popular notion that the genius is an unhealthy weakling, an unsociable recluse, a misfit who cannot get on with others, and so ill-balanced in character as to verge on actual insanity—all this, though widely held, is shown to be derived from an unfair selection of rare but sensational cases. Among extrinsic factors, Prof. Carroll lays greatest stress on the economic status of the child's family, on the competition which the budding genius meets as he grows older, and finally on a congenial marriage. But here it is necessary to remember that social and environmental conditions may operate very differently in Great Britain and in the United States.

On all these problems there is an urgent need for further psychological research; and such investigations should unquestionably form part of present preparations for post-war reconstruction.

A DICTIONARY OF PHOTOGRAPHY

Wall's Dictionary of Photography: and Reference Book for Amateur and Professional Photographers.

Edited by F. J. Mortimer. Sixteenth edition, revised and largely re-written by A. L. M. Sowerby. Pp. v+701. (London: Iliffe and Sons, Ltd., 1941.) 12*s*. 6*d*. net.

THE first edition of this book was published in 1889, since when a great deal has happened in the world of photography, and the size of the "Dictionary of Photography" has increased accordingly. The sixteenth edition, as mentioned in the preface, has been published largely because of the unexpectedly rapid exhaustion of the previous edition; but the opportunity has been taken to correct errors and generally bring the subject matter up to date, though relatively little advance has been made during the interval.

The book is essentially a reference book for the amateur and professional photographer, and is confined mainly to the theoretical principles and practical details of all generally used photographic processes. Sufficient details are in most cases given to enable the photographically minded reader to grasp the mechanism of processes, such as those of colour photography, and sufficient working details, including formulæ, to enable anyone experienced in the technique of general photography to carry them out. The physicist or chemist interested in photography will find the book extremely useful from the practical point of view, but will naturally be disappointed in many cases in the superficiality of the theoretical treatment.

It is not possible to mention all the alterations and additions that have been made since the previous edition, but the following are the most striking examples. The section on "Aerial Photography" includes an account, chiefly of topical interest, of the present technique used by the Royal Air Force. The section on "Photoelectric Exposure Meters" has been improved considerably by including a sub-section on the use of the meter, relating to the method of directing the meter towards the subject and thereby assessing the value of the 'subject' and 'light intensity' factors. It is unfortunate that no mention is made of the

Smethurst high-light meter, which has certain advantages over the more usual type of meter, especially when dealing with reversal processes, and most particularly reversal colour processes, where accuracy of exposure is of first importance. The section on "Latent Image" has been re-written to include a very brief account of the Gurney-Mott theory. It is, of course, impossible to convey even an impression of the scope of the theory in the ten lines devoted to it, and it is interesting to note that in the first edition of the Dictionary nearly a page was devoted to the theory current at the time based on the formation of a sub-halide.

As a reference book the "Dictionary of Photography" will be found extremely valuable to the general photographer, though its value might be further increased by the inclusion of more references to fuller accounts of processes and theories which, owing to limitation of space, cannot be dealt with adequately in a volume of this size. It is always difficult to discover omissions, but there appear to be few, with the exception of 'reciprocity' and 'intermittency' failure, which do not seem even to be mentioned. Surely reciprocity failure, which can manifest itself under certain conditions in ordinary photography, is worthy of mention!

APPLICATIONS OF ELASTICITY IN ENGINEERING

Theory of Plates and Shells

By Prof. S. Timoshenko. (Engineering Societies Monographs.) Pp. xii+492. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 42*s*.

PROF. TIMOSHENKO is one of the outstanding exponents of the mathematical theory of elasticity and of the application of this theory to a variety of practical problems. He has written on these topics for thirty years, and his books have become indispensable to every engineer who has to apply mathematical principles and methods to such problems.

As is so often the case, mathematical theory becomes very much simplified when approximation becomes possible, and as indicated by the title of the present book, Prof. Timoshenko discusses here the theory of elasticity as applied to problems of two dimensions, that is, to problems in which the thickness of a plate or shell can be neglected in comparison with the other dimensions.

The importance of this type of problem in practical application is too obvious to need elaboration. The hulls of ships, the walls of tanks, the domes of buildings, the boilers in engines of all kinds, and above all the vitally important light structures that can withstand great pressures necessary for the development of modern transport, particularly in aeronautics and especially in air-fighting—all these topics represent problems that come within the purview of the present book.

The development of the topics discussed in the book is in itself an interesting picture of the evolution of an engineering structure. The author begins by dealing with the bending of plates into cylindrical forms and the symmetrical bending of circular plates. The boiler or container or aeroplane fuselage begins to appear. The study of supported rectangular plates with various edge conditions portrays the placing of a structure into position. Finally, the study of shells as cylinders and as surfaces of revolution takes us into the more detailed applications to daily needs.

The author devotes only moderate attention to general theory, but deals in considerable detail with a number of definite problems which are of special importance. The mathematical treatment is very full and exhaustive, but is always clear and easy to follow. What adds greatly to the value of the book is the fact that the mathematical solutions obtained are not left in their general form, but are discussed both graphically and numerically, so that the engineer who is not a professional mathematician is shown exactly how to use the mathematical methods practically and how to get the results that he needs for his professional purposes.

At a time when the main attention of humanity is directed towards the epic struggle which is taking place in Russia, it is naturally of interest to see how Russian thought and research have contributed to general human progress. The thick and high wall of prejudice and hostility, due to mistakes and intolerance on both sides, that was set up after the War of 1914–18 between the Soviet Republics and the Western democracies, had the effect of blocking the current of scientific influence between the Russians and the world outside. But Russian science and technology, as well as Russian thought and literature, have meanwhile made great strides, and the breaking down of the wall by recent events can lead to results of great advantage to all. Prof. Timoshenko has been working in the United States for many years, but he began his important contributions to the literature of mathematical methods applied to mechanics and engineering in the Russian language nearly thirty years ago. It is a pleasure to welcome his latest book in English as a further contribution from his competent pen to this important subject.

S. BRODETSKY.

RELATIVE NUTRITIVE VALUE OF DIFFERENT FORMS OF MILK

By Dr. S. K. Kon

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Recent Government pronouncements make it clear that during the forthcoming winter there may not be enough fresh milk to go round in Great Britain, and that priority for this milk will be given to certain classes of the population, such as expectant mothers and infants. Adult consumers will receive as part of their national basic share, in addition to liquid, also some concentrated form of milk.

A brief account of the relative nutritive properties of milk in its different forms may hence be timely.

It should be realized at the outset that, from the point of view of nutritive value, milk is a variable food. Though its 'major' constituents, protein, fat, carbohydrate and ash, change but little throughout the year, some of its vitamins are subject to marked fluctuations according to the season and the nutrition of the cow. Unless this is understood, any comparison of separate types of milk of different origin would be clearly misleading, especially as concentrated forms of milk are manufacted mostly in summer and early autumn.

The importance of milk in human nutrition rests primarily on its content of first-class animal protein of high biological value, its exceptional richness in calcium, and its valuable contribution of vitamin A and of riboflavin and other water-soluble vitamins. It is generally agreed that even in peace-time, when all foods are plentiful, it is difficult to plan an adequate diet without the use of milk or milk products, and with war-time limitations this is an admitted impossibility. The unique value of milk for children, adolescents, pregnant and lactating women is now universally recognized.

With the development of our knowledge of vitamins and of methods for their accurate estimation much work has been done on the effects of commercial processing on the food value of milk, and it may be said broadly that these have proved much less drastic than was formerly believed. The idea that raw cow's milk possesses unique nutritive properties which are lost if it is exposed to any form of heat treatment is certainly not supported by the bulk of modern evidence. Losses undoubtedly occur; some are avoidable and should be prevented, others can be made good by intelligent planning of the diet.

Of the milk constituents the proteins and certain vitamins are most liable to heat injury and the extent to which this takes place can best be judged by taking raw fresh liquid milk as a base line. Typical analytical figures are given in the accompanying table, and little comment is needed on the 'major' constituents. It is probably superfluous to remind the reader that the quantity of fat varies markedly according to breed, and that the Channel Island breeds produce milk especially rich in this respect. The proteins of milk consist of casein, lactalbumin and lactoglobulin, which are almost completely digestible, and have a high biological

Composition of Different Forms of Milk[1]

Form of Milk	Calories per 100 gm.	Grams per 100 gm.					Vitamin A[2] activity		Vitamin D[2]		Vitamin B_1		Riboflavin[2]		Vitamin C[3]	
		Water	Protein (N. × 6·38)	Fat	Carbohydrate	Calcium	I.U. per 100 gm.	loss in manufacture	I.U. per 100 gm.	loss in manufacture	I.U. per 100 gm.	loss in manufacture	mgm. per 100 gm.	loss in manufacture	mgm. per 100 gm.	loss in manufacture
Raw	66	87·6	3·3	3·6	4·7	0·120	70–200	—	0·5–3·0	—	12	—	0·1–0·2	—	0–2·5	—
Pasteurized...	66	87·6	3·3	3·6	4·7	0·120	70–200	None	0·5–3·0	None	11	10%	0·1–0·2	None	0–2·0	20%
Sterilized ...	66	87·6	3·3	3·6	4·7	0·120	70–200	None	0·5–3·0	None	8	30%	0·1–0·2	None	0–1·2	50%
Spray dried whole ...	512	3·0	25·0	27·5	37·5	0·910	550–1600	None	3·9–23	None	85	10%	0·8–1·6	None	0–16	20%
Roller dried whole ...	512	3·0	25·0	27·5	37·5	0·910	550–1600	None	3·9–23	None	80	15%	0·8–1·6	None	0–13	30%
Dried skim ...	357	4·0	36·0	0·5	50·0	1·250	Trace	Most	None	All	115	10%	1·2–2·4	None	0–20	30%
Condensed whole[4]—unsweetened	169	68·5	8·4	9·2	12·0	0·300	180–500	None	1·3–7·6	None	18	40%	0·25–0·5	None	0–2·5	60%
Condensed whole—unsweetened (evaporated)[5]	144	73·0	7·0	8·0	10·0	0·260	150–430	None	1·1–6·5	None	16	40%	0·22–0·44	None	0–2·2	60%
Condensed whole—sweetened ...	344	25·0	8·8	9·5	53·5	0·325	190–530	None	1·4–8·1	None	29	10%	0·27–0·54	None	0–5·7	15%

[1] The composition varies from sample to sample; the figures given in the table may be taken as representative.
[2] Varies according to season.
[3] Varies according to the handling of the liquid milk.
[4] Product hitherto made in Great Britain in accordance with 1923 Condensed Milk Regulations.
[5] Suggested composition for product manufactured in accordance with the recently reduced standards (Condensed Milk Order, 1940) and corresponding with U.S.A. Standards.

value, that is, they can be efficiently utilized to build or replace body protein. As judged by animal experiments, this efficiency may reach some 90 per cent for raw milk.

Regarding the so-called 'minor' (on a weight basis) constituents, milk is a rich source of vitamin A, which is partly present as the provitamin, β-carotene. It is well known that milk produced on pasture is much yellower and also contains more vitamin A than milk of stall-fed cows. Under south of England conditions milk is high in vitamin A from May until November or December, when it contains some 150–200 I.U. per 100 ml., and low during the rest of the year, when the concentration drops to about half this quantity. Vitamin D, of which there is little in milk, also varies with the season, but normally it depends not on the feed, but on the direct action of the sun on the cow. There is a steep peak, therefore, around the summer solstice, which drops away sharply on either side. In May, June, July and August there are about 2·5 I.U. of vitamin D in 100 ml. of milk; during the rest of the year the content falls to one half to one fourth or even less of this figure.

Of the water-soluble vitamins riboflavin is richly represented in milk, which contains some 100 μgm. per 100 ml. during the stall-feeding period, and 150–200 μgm. when the cows are on pasture.

The vitamin C content of milk varies but little throughout the year, and is independent of the feed of the cow. The amount present in milk as it leaves the udder is appreciable, 2·0–2·5 mgm. (40–50 I.U.) per 100 ml.; one pint of such milk would supply one quarter to one third of the daily requirements of a child. Vitamin C is, however, easily destroyed in milk by exposure to light; it is at first converted into a labile form, dehydroascorbic acid, which in turn decomposes spontaneously or under the action of heat. For this reason commercial milk generally contains only a fraction of the vitamin C originally present. In any event, care should be exercised not to expose bottled milk unnecessarily to bright light.

The level of vitamin B_1 in milk is also independent of the feed, and remains constant during the year at about 12–15 I.U. per 100 ml.

Several other vitamins belonging to the vitamin B complex are also present in milk. Some of them, like nicotinic acid and vitamin B_6 are heat-stable, and are not likely to be affected by processing; the fate of others has not yet been sufficiently studied.

Milk should not be consumed raw unless it is established that it is bacteriologically safe. Rapidly brought to the boil to ensure freedom from infection, it loses little or nothing of its nutritive properties. A large part of the commercial supply of milk in Great Britain is now pasteurized by the holder method. It has been satisfactorily established that the only nutritive effects of this treatment are a loss of some 20 per cent in the vitamin C content (and this due, rather, to previous exposure to light than to heating in the course of pasteurization), and a 10 per cent decrease in the vitamin B_1 value.

In certain towns in the Midlands, such as Birmingham, and also in London, there is a demand for yet another form of liquid milk—sterilized milk. Though there is no legal definition of what sterilized milk is, it is customary to apply this term to milk which has been heated to at least 212° F. (and generally higher) for varying lengths of time. This product, usually sold in swing-stoppered bottles, has the advantage of keeping for long periods of time, and is also liked because of its 'richer' taste. Before the War it was being increasingly used in infant feeding. The drastic heat treatment to which the milk is exposed in the process of sterilization brings about a loss of some 50 per cent of the vitamin C and of about 30 per cent of the vitamin B_1 originally present. The biological value of the proteins is also slightly decreased—by about 6 per cent. There is no evidence of nutritive impairment of other constituents. Sterilized milk remains, therefore, a most valuable foodstuff, though it is not the equivalent of raw or pasteurized milk, and its shortcomings for infants and children must be recognized and repaired by the addition of necessary supplements.

The stable, concentrated forms of milk are, broadly speaking, prepared in three different ways. The moisture may be removed as completely as possible, giving dried milk powder; or it is only partly removed, and the condensed milk is either sterilized by heat treatment to ensure bacteriological purity or enough sugar is added in the process of manufacture to inhibit bacterial growth. All three methods in various modifications are applied to separated as well as to full-cream milk.

Most of the 'major' and some of the important 'minor' constituents of milk are relatively stable, and these are not affected by the various commercial processes. Thus, vitamin A and carotene, vitamin D and riboflavin survive the various methods of preservation of milk without appreciable loss. Other more labile factors suffer to a greater or lesser extent, according to the severity of the treatments.

Of these treatments drying by modern methods is generally quite mild in its effects. Spray-drying consists in principle in forcing an exceedingly fine spray of milk into a heated chamber, where it dries almost instantaneously. Spray-dried milk is nearly completely soluble in water, and 'reconstitutes' readily. In drying, it loses about 20 per cent of the vitamin C present in the raw milk and one tenth of the vitamin B_1. The proteins are only

very slightly affected, and the 'biological value' is decreased by probably not more than 5 per cent. The significance of such loss may be trivial, as in a mixed diet the various proteins supplement each other, and the biological value of the mixture need not necessarily change. The availability of the minerals of milk, and especially of the valuable calcium it contains, is not affected by the heat treatment. It is clear, therefore, that spray-dried milk retains to a remarkable extent the nutritive qualities of the fresh product.

Another method of drying consists in rapidly dehydrating a thin film of milk on steam-heated revolving metal cylinders, from which it is removed by means of a stationary scraper. First-quality roller-dried milk is, from a nutritional point of view, only slightly inferior to the best spray-dried product, though its solubility in water is generally lower. As a rule, the loss in vitamin C is slightly higher, nearer 30 per cent, and the deterioration of the proteins is rather more noticeable. In some less satisfactory samples up to one third of the vitamin B_1 may be lost. Occasionally spray- or roller-dried milk is encountered in which the losses in vitamin C are much more severe than those just quoted. This is largely due to the practice obtaining in some factories of mixing the bulked milk before drying by bubbling air through it. Full-dream dried milks keep quite well when properly packed in hermetically sealed containers. They ceteriorate, however, on exposure to the air.

Cream has proverbially been considered as the most valuable part of milk, and milk from which the fat had been removed has borne a stigma of inferiority. Even now, when the full food value of milk is much better understood, there is still widespread prejudice against the use of skim milk in human nutrition. In the liquid state it was seldom used for this purpose in Great Britain before the War. Dried, it went into consumption concealed in bakery goods, ice cream, confectioneries and breakfast cereals. Even in the United States, where its use as human food is much more widespread than in Great Britain, some 40 per cent of the dry skim milk was used as animal fodder. Yet, when its limitations are properly understood, it is a most valuable food. The absence of fat and of vitamins A and D make it totally unsuitable as a food for babies, and in Great Britain it must be clearly labelled to this effect. All the other important constituents of milk remain, however, unimpaired, and for that matter, proportionally increased at the expense of the missing fat. The high content of animal protein, calcium and riboflavin makes skim milk a most valuable addition to war-time dietaries. Vitamin C and vitamin B_1 are higher than in full-cream milk, and the important, though less well-defined other members of the vitamin B complex are also there in relatively increased amounts. If protected from moisture, dried skim milk keeps almost indefinitely and without need for special packing. Relative cheapness and ease of transport emphasize its value in war-time, and it is to be hoped that as much of it as possible will be made available for general consumption.

Of the milk products from which water is only partly removed, unsweetened condensed milk, generally known as evaporated, is exposed to the more drastic heat treatment. The concentration itself is carried out *in vacuo* at low temperature, but the milk is then placed in tins which are sealed and sterilized by heat at a temperature of 240° F. This exerts noticeable effects on the more labile components. Some 60 per cent of the vitamin C, and 30–50 per cent of the vitamin B_1, are lost. The digestibility and biological value of the proteins decrease slightly but unmistakably. Other factors, so far as is known, remain unimpaired, and the good record of evaporated milk in the feeding of infants and children shows that when its known defects are remedied it remains a food of outstanding value.

Sweetened condensed milk is not exposed to temperatures above the boiling-point of water, and frequently the maximum temperature is well below this. Sugar, which is added before condensing, reaches a final concentration of about 40 per cent and effectively prevents the growth of micro-organisms. In up-to-date sweetened condensed milk the losses of nutrients are quite small. Thus, a good specimen may contain only 15 per cent less vitamin C, and 5–10 per cent less vitamin B_1 than were originally present in an equivalent quantity of the fresh milk before manufacture.

In assessing the food value of different types of milk it should be remembered that dried milks are concentrated about $7\frac{1}{2}$–$7\frac{3}{4}$ times in comparison with fresh milk, and unsweetened condensed milk about $2\frac{3}{4}$ times. Hence, the amount of milk solids varies in the different products, but the composition of these solids remains the same. It is altered, however, in sweetened condensed milk by the presence of large amounts of sugar, and this type of milk is richer in total solids than evaporated (unsweetened condensed) milk, though the concentration of the milk solids is roughly the same in both. Such assessments show that the alternative forms of milk which may be offered to the adult population will be perfectly satisfactory from a nutritional point of view, even though their use may entail some readjustment of established food habits. The essential point is to ensure the maximum possible supply of milk in any form for adults, and to reserve a full quota of liquid milk for children and expectant and lactating mothers.

J. A. KOMENSKÝ (COMENIUS), 1592-1670

BY DR. GERALD DRUCE

THREE hundred years ago there arrived in England a Czech exile, Jan Amos Komenský, better known by the Latinized form of his name, Comenius. This refugee from an earlier persecution of his nation came at the invitation of Parliament in order to lay before contemporary men of learning his views on education and the organization of science in the service of mankind. It was, therefore, appropriate that the tercentenary of Comenius's visit was commemorated at Cambridge on October 24.

Convened by Dr. Joseph Needham and under the presidency of the vice-chancellor, Dr. J. A. Venn, the meeting was attended by representatives of the U.S.S.R., Holland, Poland and Sweden, as well as by Czechoslovak and British men of science and learning. Papers were read by President Beneš ("Comenius' Plans for Peace Leagues and his Place in History as a Great European"), Mr. J.L. Paton ("Comenius as an Educational Pioneer"), Prof. J. D. Bernal ("Comenius' 'Pansophic College' and the Rise of Scientific Societies in the 17th Century") and Prof. E. Barker ("The Debt of Europe to Czechoslovakia and to Comenius"). Others present also paid tribute to the personality and achievements of the great Czechoslovak pioneer (see NATURE of November 1, p. 518).

Born of Protestant parents at Uherský Brod, Moravia, in 1592, Comenius had a local schooling which was followed by residence at Herborn, a Calvinist academy in Nassau. Before returning home he visited Amsterdam and Heidelberg. He became a teacher in 1614 and in 1618–19 he was headmaster of a school at Fulnek in north Moravia. These were critical years in Czech history, parallel with 1938–39. Disaster followed, Bohemia lost its independence and persecution set in. Comenius first moved to the estates of Charles of Žerotín, in east Bohemia, not far from the frontier over which he escaped to Leszno, in Poland, in 1627. Here he started a very successful secondary school for the Czech colony in this part of Poland.

He was also able to print tracts and works that he had written earlier. In 1622 he had completed the first accurate map of Moravia. Then came his "Labyrint Světa a Raj Srdce" (Labyrinth of the World and the Paradise of the Heart), an allegory written in an endeavour to escape from mental depression during anxious years. It describes a pilgrimage to an imaginary city, a method that the author adopted to direct attention to the social injustices, cruelty and dishonesty of his time. Remedies are suggested, and the consequences likely to follow, if the evils are allowed to continue, are foreshadowed.

At Leszno Comenius produced a new type of Latin grammar, "Janua Linguarum Reserata" (1631). Its plan was to impart, as well as Latin, useful general knowledge concerning everyday life and simple science. Instead of giving grammatical rules and exceptions, Comenius's method was to begin with simple phrases and gradually progress to complex sentences. The method was very successful and the "Janua" was translated into twelve European and four Asiatic languages. Some thirty of its sections are devoted to natural history, sixteen to arts and crafts (gardening included), twenty to learning and culture, five to social affairs, ten to ethics, eleven to politics and six to religion.

Comenius began to formulate his pansophic plans as a student at Herborn under the influence of J. H. Alsted. He printed the first part of his "Great Didactic" at Leszno in 1627 under the title, "Didaktika čili umění umělého vyučovaní" (Didactics or the Art of Teaching), with a supplement relating to the establishment of schools in Bohemia when victory came. Though Comenius probably obtained some of his ideas from Alsted and from J. V. Andreæ (whom he met at Heidelberg) and was also influenced by the works of Francis Bacon, the comprehensive conception of this educational scheme was his own and shows how much he was in advance of the times. That he possessed modern notions of the purpose and methods of education, to develop intelligence and to impart real knowledge and to maintain a progress from the known to the unknown, is apparent from the earliest edition of this work, which reached its final form and appeared in Latin as "Didactica Opera Omnia" (Amsterdam, 1657).

Comenius divided schooling into four grades: (1) In the family up to six years of age. (2) In the mother-tongue (primary) school from six to twelve. (3) In the higher (grammar) school from twelve to eighteen. (4) At the university after eighteen.

This system of education was to be available to all children without regard to station or sex, but higher education was to be based only upon merit. At school Comenius had been taught one subject, Latin, and that badly. He lamented that much useful knowledge was never taught or new discoveries (for example, those of Copernicus) even mentioned. Therefore, in his mother-school

curriculum he included observations on common objects and phenomena in most of the sciences. He claimed that in his first six years even, a boy can be brought to know something of water, earth, air, fire, rain, snow, frost, stone, metals, trees, plants, birds, fishes, etc. He can learn something of his own body and so be ready for systematic science at the grammar school. Comenius applies the same reasoning to his method of introducing the pupil to optics, astronomy, geography, history and mathematics and mechanics.

According to Comenius, the training to be completed at the university should be really universal and include every branch of knowledge. Positions of honour should be given only to those who have completed their university course and shown themselves fit to be entrusted with the management of affairs. For this final stage of education Comenius aimed at a compilation of all established facts from every branch of the sciences. The first part was published at Leipzig in 1633 under the title, "Physicæ at lumen divinum reformatæ synopsis". It included contemporary alchemy, cosmology, astronomy and anthropology, while current superstitions were not excluded. This work, in which Comenius emphasized the unity of all knowledge, was eventually translated into English by John Dury (1651). But the pansophic plans of Comenius became known here much earlier through Samuel Hartlib, a Pole from Elbing, who spent much time in England. Hartlib published two tracts, "Prāeludia conatuum pansophicorum Comenii" (Oxford, 1637) and an "Essay towards Compleat Wisdom" (London, 1639), so that the ground was prepared for Comenius to come to England. He was now widely known in Europe—and indeed in the New World, for there is a legend that he was invited to Harvard, and certainly his advice was sought concerning the education of American Indians, a matter in which Robert Boyle also was interested.

Comenius arrived in England in September 1641, and became acquainted with the leading men of learning, including Bishop Williams of Lincoln (later Archbishop of York and a great patron of science), Lord Brooke, John Pell, Theodor Haak, Sir Cheney Culpeper, Robert Boyle and John Selden, all of whom showed an interest in his plans. They discussed schemes for establishing an international academy or pansophic college (three sites were considered) which was to be "a living laboratory supplying sap, vitality and strength to all". The work of compiling a comprehensive encyclopædia of science was to be conducted by a number of specialists and assistants working under Comenius's direction.

At first there seemed every prospect of success, but the outbreak of the Civil War in 1642 caused the scheme to be abandoned, and Comenius returned to the Continent. It would, however, be incorrect to suppose that Comenius's visit had been in vain. His views and objects had been well received and he continued to correspond with Hartlib, Boyle, Dury and others. When the Royal Society was founded in 1662, Comenius was overjoyed and hastened to dedicate his "Via lucis" to the fellows, whom he addressed as "the torchbearers of this enlightened age", especially urging them not to neglect metaphysics. It may be pointed out that the expression "Invisible College", applied to the periodical meetings of those who later founded the Royal Society, may have originated from Comenius's reference to the projected pansophic academy as a "Collegium Lucis".

After further visits to Sweden, Poland and Hungary, Comenius eventually settled in Holland, writing alternately educational and pansophic works. Besides his country's persecutors he had philosophical adversaries. Thus, Descartes criticized his works on the ground that he mixed theology with philosophy. This refers, no doubt, to the fact that since 1631 Comenius had been a bishop of the "Unitas Fratrum", or Bohemian Brethren. Others contended that he attempted to spread Calvinism under the cloak of pansophy, while Samuel Desmarets, a Dutch contemporary, went so far as to describe him as "a mystical beggar with a commercial instinct". Comenius replied to these unfair charges by further explanations of his pansophic principles. His intention was to organize knowledge and apply it for the moral and material benefit of his fellow-Europeans.

The Thirty Years' War came to an end in 1648 when the exhausted belligerents signed the Peace of Westphalia. The terms left the kingdom of Bohemia (which included Moravia) in the hands of her enemies. For this Comenius bitterly reproached Oxenstiern, the Swedish plenipotentiary, who had promised that Bohemia would not be forgotten. But if he had lost his fatherland, Comenius found that he had become a citizen of the world. To his Czech compatriots he addressed a "Last Testament of a Dying Mother" (Kšaft umírající matky Jednoty bratrské) in which he made his famous prophecy, "I believe that, after the tempest of God's wrath . . . shall have passed, the rule of thy country will again return unto thee, O Czech people".

It was in these circumstances, too, that he wrote ("Panegersia"), "We are all fellow-citizens of one world, all of one blood, all of us human beings. Before our eyes there is only one aim—the good of humanity". The claim to regard Comenius as a great European can also be illustrated from

his "Angelus Pacis" (Amsterdam, 1667), addressed to English and Dutch plenipotentiaries, which contains a plea to all nations to abandon war and establish courts of peace for international consultations and the direction of human affairs. Whether a pansophic academy would have achieved the objects that Comenius had in view may be doubted. He was in advance of his age, and, apart from the far-seeing savants who founded the Royal Society, there were few who showed enthusiasm for his projects. No one on the Continent was prepared to do more than support the printing of his books and, indeed, it is only in modern times that international organizations have begun to function.

G. W. Leibniz (1642–1716), who was of Slav origin, showed a sympathetic interest in Comenius and assimilated his ideas regarding encyclopædic compilations and scientific societies, restating them and implementing them as completely as the unsettled state of Europe allowed.

Nor were Comenius's educational endeavours to meet with immediate success. He was a realist at a time when his contemporaries still learned their natural history from Aristotle and Pliny. Problems were 'settled' by reference to the writings of the authorities even after Comenius had asked, "Do not we ourselves dwell in the garden of Nature as well as the ancients? Why should not we use our eyes, ears and noses as well as they? Why should we need other teachers than these our own senses? Let the children touch, feel, see, hear and find out by experiment for themselves, draw the object, measure it and understand it".

To generations of his own countrymen Comenius has served as an inspiring example. They named the new University of Bratislava and also the Czechoslovak secondary school in Vienna after him. His energy and fortitude can serve to-day as a stimulus to us all to continue steadfastly working for those same ideals which we know to be true.

The papers read at the Cambridge tercentenary meeting are to be made available in a permanent form. Other recent works on the life and activities of Comenius are the following: "Comenius in England" by Dr. R. F. Young (Oxford University Press, 1932); "Comenius and the Red Indians of New England" by Dr. R. F. Young (1929); "Comenius" by W. M. Keatinge (McGraw Hill, 1931); and "Johannes Amos Comenius" by Dr. J. Jakubec (Orbis, Prague, 1928). Prof. R. J. Kerner's "Czechoslovakia" (University of California Press, 1940) also contains references to Comenius.

SCIENTIFIC KNOWLEDGE AND ACTION*

BY SIR RICHARD GREGORY, BART., F.R.S.

IN the study of man and his activities three types of cultural development may be recognized; and they are all measured by different standards. In the fine arts the imaginative qualities of the mind appeal primarily to the emotions through stimulation of the æsthetic judgment; material culture is the province of the industrial arts; and science—the domain of reason—is systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political.

Natural science, or natural philosophy, is only one division of science as thus defined, yet, in general usage, the single word 'science' signifies verifiable knowledge acquired by observation and experiment. The history of civilization from this point of view is a history of intellectual development in which science has been the chief factor in changing habits of thought from superficial observation and magical theories of causation to clear concepts, rational conclusions, and progressive principles in the advancement of man and society.

It is common in these days to think of progress in terms of material development and to leave out of consideration the contacts of science with what is known as 'polite' learning—literature, religion, and other expressions of the human spirit. The noblest works of man are not, however, represented by great industrial advances, but by the search for the truths upon which they are based, and by the influence of this effort upon personal and social ethics.

In the pursuit of natural knowledge, the common object is to solve problems of life and thought; and all additions to knowledge thus gained contribute to the world's store, whether they admit of immediate practical application or are deposited in the archives of science for safe keeping. There can be scientific knowledge without action, and action without scientific knowledge; and the two are combined in applied science for practical service. There are, however, many aspects of Nature

* From the Hinchley Memorial Lecture delivered before the Institution of Chemical Engineers on October 24.

which appeal to the human mind, in addition to those in which usefulness is the measure of achievement. Purely scientific studies may claim to represent this attitude towards knowledge for its own sake and to be responses to a stimulus more exalted than that derived solely from material aims. So long as this spirit prevails, the influence of the high ideals of truth-seeking associated with scientific research will be extended : without them, science becomes a business in which the highest attributes and needs of human nature take no part.

Concepts of natural causes and phenomena must change with increased insight and inquiry, whether the interpretations represented by them are myths or scientific theories. Science asks for no faith in theories, except as reasonable explanations based upon verifiable observations, or as suggestive schemes which may or may not be found true when tested by further knowledge. Its duty is to observe with open eye and unprejudiced mind the picture presented by Nature, and to get nearer and nearer to the view. No loss of the sense of beauty need be involved in the analysis of the details which create the picture. The scientific mind is not satisfied with distant views and is critical of itself and its conclusions. It must, however, record faithfully what it perceives, knowing that the value of the record will be measured by its approach to permanent truth. True to Nature is the highest tribute that can be paid to a scientific testimony, as it is also to reflexions of Nature expressed in art and literature.

Observations carefully made and precisely recorded may be used or explained in various ways, but they are part of the permanent structure of natural knowledge. Whether undertaken with direct practical service in mind, or purely in the spirit of interest in natural objects and processes, is unimportant in comparison with the perception they afford of natural truths. In this respect, all who contribute to the store of verifiable knowledge increase the useful and the intellectual heritages of the human race.

Man is, indeed, more than an animal needing food and shelter and other essential means of existence : he seeks also to understand the nature and meaning of these things, usually with the view of deriving advantage for himself and for others from his discoveries, but often also with the desire to satisfy his curiosity in the object and operations of Nature. The common aim is to obtain information by inquiry and experience, though the motive in one type of observer is application of the knowledge gained, while in the other it is to explore the unknown and explain the mysterious. The standard of value of one is use and of the other intellectual satisfaction ; and the difference between the two is that between practical service and philosophy.

The discovery that certain natural events were repeated in orderly succession, and that their re-occurrence could be predicted, was a practical generalization from systematic observations, and revealed, therefore, a natural truth or law. If a generalization is well founded, it remains true independently of speculations as to the powers or causes which create and control the natural phenomena observed.

At all times, Nature has created wonder in the human mind as well as the desire to use and understand the proximate or ultimate causes of what is perceived by the senses. Knowledge of natural properties and effects was first acquired to supply needs of the body, and their interpretation as influences of spirits in the empyrean had mystery as its basis. The separation of the study of Nature from that of personal deities may be said to have begun with the Greeks. In the sixth century before the Christian era, Thales, Xenophanes and Pythagoras first opened up those veins of speculative philosophy which occupied afterwards so large a part of Greek intellectual energy. It is in their philosophies that the idea of an impersonal Nature was considered as a subject of study apart from mythical conceptions. They defined the scope of natural philosophy with its objective character and invariable laws, discoverable by the exercise of human intellect, and they first used the word *phusis*, signifying Nature and surviving in the words physics, physiology, physiography, and similar derivatives, to distinguish such studies from theology.

When early Greek philosophers began to speculate upon the nature of the universe and the meaning of life they introduced the spirit of liberty of thought in inquiring into all things—sacred, social or political—independent of authority, and thus established the principle of intellectual freedom essential for the advance of science, art, literature, or any other aspect of civilized culture. Many of their speculations were crude in the light of modern knowledge, but they all represented attempts to apply reason to the problems presented to human senses, and some have proved to be of fundamental significance. The particular contributions of the Greeks were not in the technical arts and crafts, or in knowledge gained by observation and experiment, but in generalized thinking about universals. Their characteristic was creative thought and theory on intellectual planes as far removed from needs of the body as mind is apart from matter. They used knowledge of natural properties and processes, acquired by observers and craftsmen before the classical period, not as useful applications of science but to construct philosophic systems which were logically sound and therefore required no other proof. It was believed

that truth in Nature could be revealed by abstract thought, without the slow and laborious process of learning by experience what things or circumstances in earth or sky could be applied to useful human service. Passive contemplation has an appearance of dignity not usually associated with the active exercise of either hands or brain.

When manual work of any kind began to be regarded as a menial occupation, and meditation became the characteristic of a higher social class, a distinction was created between useful knowledge and academic or philosophic thought. Pure science has thus come to mean natural knowledge acquired for itself alone, and studies without particular useful purposes in mind. Similarly, a pure chemist is said to be one whose active interests are confined to chemistry, while a pure biologist has physical life as his field of study. The word 'pure' used in this sense is objectionable for several reasons. Chemistry and biology, like other sciences, cannot be sharply separated from the main body of natural knowledge, but often merge into one another and lead to new productive branches, so that pure biochemists come into being, and members of the families of physics and chemistry, long separated by verbal distinctions, unite to produce the fertile line of physical chemists.

In general, however, it may be said that the main distinction between pure and applied science arises from exclusive attention to theory and practice respectively. Applied science is concerned directly with theory only as a generalization or principle which relates natural causes to consequences and enables new effects to be predicted. It is based upon observation, and its aim is the production of new agents or powers for the service of man. In most scientific societies, the passport to publication in their records is obtained by observational inquiry of a practical kind or original conceptions suggested by them. In their pursuit of natural knowledge by methods of observation and experiment, independent adventurers and practical prospectors meet on common ground, whether the purpose of inquiry is knowledge itself or its application.

In one of his aphorisms, Francis Bacon said that "All knowledge should be referred to use and action". On this narrow view, the value of scientific work is measured in terms of application to human service, without consideration of the dignity of knowledge and the intellectual aspiration to attain it. It is true that the main object of Bacon's new philosophy was to enlarge the dominion of man by increasing his knowledge and control of operations of Nature; and in this sense the standard of scientific achievement is service. Whether his philosophy was limited to this outlook is, however, unimportant in comparison with his advocacy of independent observations of natural operations and events, and legitimate inferences from them, free from prejudice and to be judged only by their faithfulness to natural truth. Whatever views may be held as to the inter relationships between science and society, civilized life is shaped by the uses to which scientific discoveries are put; and the spirit and method of scientific inquiry are now accepted as essential principles in the pursuit of truth through verifiable evidence of any kind.

Theories based upon such evidence are mental models of structures and actions for use as stepping-stones to further knowledge, and they have to be modified or discarded when they fail to satisfy crucial tests of their validity. Most natural philosophers are content to base their understanding of Nature upon the solid ground of observed facts, and to leave ultimate meanings to metaphysical minds. They are constructional engineers continually building bridges to cross into new territories and using materials of which they have discovered or created properties of practical value in the execution of the design. As the traffic of science increases, such bridges have to be replaced from time to time by others of newer designs and better materials; but the purpose is, as it is in all forms of organic life, the efficient adaptation of structure to function.

Artists and poets may use their imaginations to construct scenes and cities having no factual foundation; and without deliberate intention they sometimes anticipate designs and developments which eventually come to pass. Such conceptions of truth belong, however, to mysticism rather than to realism. The anticipations of expanding applications of scientific discoveries and their social consequences, made by Mr. H. G. Wells in many of his outlooks upon life, are of a very different character. They are similar in nature to scientific theories in which new relationships are foreseen from observed reactions, and are afterwards confirmed. They represent the products of a disciplined imagination working upon existing knowledge with the wide vision and adventurous insight by which the greatest advances have been made in both pure and applied science. It is in this spirit, and by the recognition of possibilities in opportunities presented by new contributions to knowledge, that material progress is achieved in industry and in science.

In these aspects of progress, theory and practice are complementary factors of service, each being used to reconstruct the other by relating effect to cause. This is the method of Bacon's inductive philosophy; and the achievements of modern science are due to its application. It is possible, however, to arrive at generalizations about the

nature of things and the structure of the universe by theoretical reasoning independently, or largely so, of observational or experimental evidence. With a few great exceptions, this was the method of approach of classical Greek philosophers towards problems of Nature; and it takes an important place in the history of science. They gave little consideration to the practical or useful services of science represented by chemistry, mechanics and engineering, but they take a supreme place by their philosophic and mathematical contributions. Many Greek philosophers meditated upon the nature of matter and space, each conceiving theories of primary elements or substances from which everything in the universe was formed and evolved. Abstract ideas about causes were discussed as propositions to be established or rejected by logical reasoning independently of knowledge perceptible by the senses.

Following this method of interpreting Nature by thought alone, Democritus, in the fifth century B.C., conceived the theory that the universe is made up of atoms varying in size and shape and moving in a vacuum. The atoms were indivisible particles and infinite in number; and by their motions and combinations with one another the world and all in it were produced. This atomic theory of the universe was taught a century later by Epicurus, whose philosophy was embodied by Lucretius in his great poem, "De Rerum Natura", in the first century B.C. The theory remained a philosophic conception until the beginning of the nineteenth century, when Dalton gave scientific precision to it. To Dalton, as to the Greek philosophers, an atom meant "the smallest possible quantity of any element which can combine with other substances", and the three laws formulated by him as to the structure of bodies by atoms are the foundations of modern chemical science.

These principles still hold good to explain chemical constitutions and changes, though there has been a complete revolution in conceptions of the structure of atoms themselves. In this revolution, however, theory has been used to account for observed properties and to forecast new effects from known causes. So long as the operations of the mental model thus constructed proceed according to plan it serves a useful purpose by providing points and movements of attack and defence. When opposing forces or natural obstacles reveal weaknesses in the system, adjustments have to be made to meet them. Expressed in another way, schemes of operations in the battlefield of science are not final orders to be followed without question, but working hypotheses which have continually to be modified to meet changing requirements of the front line.

In the fields of applied science, usefulness is the standard of value of both fact and theory. Natural relationships and laws represent the accumulation and collation of empirical knowledge, and nothing more is desired or claimed of them than service in action. Whether such generalizations, arrived at by theoretical and experimental research, are causally repetitional, and have no other significance, is too abstract a proposition to influence the activities of scientific workers generally in laboratory or field. When, however, the special theory of relativity, the quantum theory, the indeterminancy principle, and similar mathematical conceptions become factors which have to be taken into consideration in constructing rational schemes of structure and happenings in atoms and the universe, physical laws appear to be only convenient rule-of-thumb guides to practice and not ultimate truths.

Most scientific workers are satisfied with confirmatory experiment or observation as a test of the validity of a theory or principle. Clerk Maxwell's electromagnetic equations were of this type and were established as true by the experiments of Hertz and Lodge. Mathematical equations thus interpreted in physical phenomena often develop, however, into broader schemes and suggest that other states or conditions exist for which no objective proof may be attainable. In arriving at such equations upon purely mathematical principles, it is permissible to assume properties and relationships without reference to conscious knowledge of them. Though only a few of these revelations of the mind find contact with reality, while the rest belong to the realm of ideals, the general shape of the structure depends upon mathematical reasoning, which may be logically sound even when it does not coincide with observational knowledge.

The right of mathematicians to construct schemes of this kind, in which laws are derived from *a priori* concepts, must be conceded, however unsubstantial such flights of imagination may appear to practical minds. A physical law is not an unalterable creed, but a statement of knowledge of particular relationships of Nature derived from observation and experience. It has to be altered when cases arise which are not covered by it, and is not, therefore, a permanent statute. No scientific mind supposes that a physical law is among the eternal verities or a faith which it is sacrilege to assail.

There are other rational standards of value in Nature, in addition to those based upon scientific methods of inquiry. The inductive method is usually employed to construct theories of the nature of the universe from what has been discovered as to the constitution and distribution of

the bodies in it, but such theories can obviously be nothing more than rational pictures painted in the pigments available at the time. As they must change with the expansion of theoretical and observational knowledge, they can never be more than temporary schemes which explain what is known when they are expressed, and suggest a possible past and future history from present appearances. Mathematics and philosophy are, however, not confined to known laws of Nature or to observable phenomena : though these may be used in constructing mechanical systems of the universe, they are not essential factors in mathematical conceptions, any more than they are in poetic flights of fancy. Ideas as to the origin and construction of the universe, based on logical mathematical principles, can only be refuted, therefore, by positive evidence of their untruth, and not by the apparent lack of contact with what is known when they are put forward.

Our senses determine the range of objective phenomena, but creative thought has no such limitations. It is the source of the greatest human achievements, whether expressed in music and poetry or in scientific discovery and invention. Its exercise is determined not by what is known but by what is unknown ; and whether a pursuit is worth while must be measured by originality of intention and result rather than by direct intellectual or practical service. Here, then, is the common standard by which all scientific inquiries, and all expressions of human feelings, may be judged. It makes no distinction between pure and applied science, so long as the object is increase of knowledge and the endeavour is the discovery of truth.

When this is borne in mind, the pursuit of knowledge for its own sake becomes just as estimable an occupation as that in which the purpose is use or action. It is generally acknowledged that inquiries undertaken to solve purely scientific problems, and without thought of their proximate or ultimate usefulness, have been the starting points of most of the great achievements of modern science ; but such problems need not be excluded in planning scientific work for the benefit of the community. Science has transformed so many aspects of modern civilization that structures of society designed in earlier times have been shaken to their foundations by it. Its sources and resources, if they are wisely used, give almost unlimited powers to construct a world in which life can be made worth living to all peoples of the earth.

Systems of planning with these objects in view have to provide not only for the full use of existing knowledge but also for efficient means of extending it. Most scientific inquiries are best advanced when groups of workers concentrate attention upon them, whether intellectual interest or industrial application is the motive. It is, however, as impossible as it is undesirable to attempt to limit creative thought to a particular pattern, or to apply the criterion of usefulness to its exercise. This is as true of science as it is of other activities in which hand and brain combine to express themselves in new products. Men of science, like musical composers and other artists, may follow their occupations as a means of living, but their most original achievements are those which depend for their expression upon inborn light rather than external influences. In every walk in life, both interest and pleasure are required for contented effort, but they are not always to be hired in the market place. They are at their best when they are exercised in perfect freedom, whether in craftsmanship or in the expression of human consciousness.

STRUCTURE OF LIQUID METALS

BY DR. A. LATIN

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THE view that the arrangement of atoms or molecules in a liquid is not entirely random may now be considered well established. In other words, the liquid possesses certain characteristics to which the term 'structure' can be properly applied. This does not mean that a liquid possesses anything so definite as a 'lattice structure', and any reference to a 'liquid lattice' may be very misleading, if not, indeed, devoid of meaning. It would perhaps be allowable to refer to the 'ghost of a lattice. Before going on to consider liquid metals themselves, it will be as well to deal first with the general question of the structure of liquids.

There are perhaps two main types of conception of liquid structure that have proved of value. These may be termed (1) group and (2) statistical conceptions. In some ways, indeed, these con-

ceptions have tended to merge into one another and perhaps their chief distinction is in the difference of mental picture that they give. Thus one view or the other may prove of the more value according to the particular case under consideration.

Theories of the first type postulate the existence in the liquid of minute groups of atoms or molecules possessing a more or less high degree of order, particularly at temperatures near the melting point. Such theories have been put forward, for example, to account for the increase in supercooling on freezing with the degree of original superheat. This implies a higher degree of order (or a greater number of 'seed crystals') in a freshly melted liquid than in one which has been superheated. There is considerable evidence, however, favouring the alternative view that the effect is due to the presence of impurities which, in one way or another, furnish nuclei for crystallization. Even in the case of the so-called 'liquid crystals', there appears to be no evidence of any very definite regularity of arrangement of the molecules, other than a common orientation. Perhaps the most elegant development of the group type of conception is Stewart's theory of 'cybotaxis'. In this the groups are considered to be of a transitory nature, continually forming and disappearing. The mental picture of the liquid is, so to speak, 'spotted' and ever-changing.

In the purely statistical type of conception, the liquid is regarded as being essentially molecularly homogeneous. There is, however, a tendency for the molecules to concentrate in certain favourable positions with respect to neighbouring molecules. In other words, there is a maximum probability of nearby molecules being situate in certain more or less well-defined positions with respect to one another. The distribution function representing the statistical radial distribution of molecules around an average molecule possesses peaks which become less marked as the distance increases. Moreover, there appears in many cases to be a distinct resemblance between the form of this function and that of the equivalent discrete function by which the structure of the crystalline solid may be represented.

A valuable insight into the nature of liquid structure can be obtained from a consideration of modern theories of fusion. These deal with fusion as a type of order–disorder process, analogous to that which takes place in certain solid alloys, but with the difference that the lattice itself, as it were, melts. In more general terms, the process of fusion may be included with the other so-called 'co-operative' processes, the statistical mechanics of which have been studied by Guggenheim and Fowler. The obvious corollary to this conception is that a certain degree of regularity must persist in the liquid. Similar considerations applied to the reverse process of freezing should be capable of giving more fundamental information into the mechanism of supercooling and nucleus formation than is obtained from either the conceptions of Miers or of Tammann, and it is obvious that much valuable work remains to be done on this side of the problem.

The most direct evidence favouring the above views of liquid structure, although there is a body of more circumstantial evidence from other sources, is that obtained by X-ray studies. The halo or haloes produced when a monochromatic beam of X-rays is passed through a liquid were early shown by Debye and Scherrer to be due to interference. Moreover, the Bragg spacing calculated from the most intense halo is in general of the same order as for the principal plane in the crystalline solid.

There is no space here to go fully into the question of the interpretation of the X-ray diagrams, but two main methods may be very briefly described: (1) a 'model' of the liquid structure, based on the influence of the thermal vibrations on the structure of the crystal, may first be proposed, the theoretical X-ray intensity diagram derived from this, and then compared with the actual diagram. (2) From what is essentially a Fourier analysis of the X-ray intensity diagram the distribution function of the liquid is obtained. Naturally, further interpretation, and even further data, are necessary for this distribution function to be made to yield a detailed picture of the liquid structure. This latter is probably the most difficult aspect of the matter.

X-ray studies have as yet been applied to only a few metals in the liquid state, but it seems already possible to draw certain tentative conclusions.

Of the close-packed metals lead, thallium and aluminium have been examined. All investigators agree that the liquids have a close-packed structure; that is to say, the atoms may be imagined as equal spheres which, while in continual motion, tend to remain always closely packed together. The inference is that there occur in the liquid, configurations bearing a relationship to those in the crystalline solid.

The body-centred cubic alkali metals have received considerable attention. Tarasov and Warren, for example, have shown that there exists a similarity between the atomic distribution of liquid and solid sodium. Their work has been followed up by Trimble and Gingrich, on the basis of whose results Wall has derived an interesting form of distribution function for liquid sodium. In his model each atom is imagined as being trapped in a spherical shell, the shells themselves being dis-

tributed in an arrangement of a 'quasi-solid' type. He shows that the chief effect of temperature is in influencing the shell radius, this being 0·60 A. at 100° C. and 0·77 A. at 400° C. One may perhaps conclude from this that a fairly high degree of regularity, related to the body-centred cubic arrangement in the solid, may be present near the freezing-point.

Coming to metals deviating more markedly from close-packing in the solid state, mercury, naturally, has been studied by many investigators. All agree in imputing to liquid mercury a close-packed structure. Solid mercury is rhombohedral, with a co-ordination number of 6, and the structure of the liquid may perhaps be most simply regarded as the result of the increased freedom given to the atoms on melting. Kratky has argued that a hexagonal close-packing fits the results best, but it seems unlikely that there can be much real difference between hexagonal and cubic close-packing in a structure so irregular as that of a liquid.

Bismuth is of particular interest in view of the large amount of work, in other connexions, of Goetz and his collaborators on this metal in the liquid state. There is some evidence of so-called 'pre-melting' in bismuth, and its melting point would appear to be not so sharp as for the close-packed metals. The results of the few X-ray investigations are conflicting. Randall and Rooksby find a band spacing identical with that for liquid lead, and consider that liquid bismuth has a close-packed structure. Solid bismuth has a structure differing widely from that of the close-packed metals, but, as Randall and Rooksby have pointed out, there are certain similarities to lead, its neighbour in the periodic system. Their view may be said to amount to the conclusion that this similarity increases on melting. They cite the changes in diamagnetism and electrical conductivity as affording more evidence in favour of this view. The results of Prins agree with the close-packed theory, but Danilov and Radtchenko consider that a 'blurred' simple cubic lattice fits their results best. The structure of solid bismuth is often considered as a slightly distorted simple cubic one.

As a result of his experiments, Goetz, particularly in connexion with his 'block' theory of the structure of crystals, has put forward the view that in liquid bismuth there persist, up to about 10° C. above the melting-point, groups of atoms, under certain conditions quite large, having a highly regular arrangement closely allied to the structure of the solid. His theory has received considerable criticism, and it would seem that more certain evidence is necessary to substantiate it. To me, it seems a possibility that the change which takes place in bismuth on melting is, from one point of view, analogous to an order–disorder change in a solid alloy, accompanied (as is not infrequent) by a change in lattice form. The possibility of cybotaxis also exists.

X-ray investigations have also been made on liquid tin, but will not be dealt with here. Of perhaps greater interest are the results on gallium, as representing a 'borderline' case, or highly abnormal metal; also because Menke has carried out an investigation on the supercooled liquid, at 18° C. (m.p. = 30° C.). The intensity diagram shows a pronounced 'ridge' near the principal maximum. A similar effect occurs with water. The structure of solid gallium is complex, and there is evidence of molecular binding. The simplest conclusion is that some degree of molecular binding and relationship to the solid, possibly with cybotaxis, occurs in the liquid. On the other hand, it also seems not unlikely that a definite change in structural characteristics occurs on melting. It is noteworthy that supercooling would seem to be more marked in those metals, for example, bismuth and gallium, in which such a change takes place, than in metals such as the close-packed ones, in which the structural characteristics of liquid and solid appear to be more closely allied.

A few alloys have also been investigated in the liquid state by X-ray methods. The results on intermetallic compounds indicate a certain degree of stability in the liquid state. Bornemann's measurements of the electrical conductivity of liquid alloys also confirm this. In view of the electron-atom ratio theory of the structure of intermetallic compounds, these results are of interest in indicating that the forces responsible for the structure of solid intermetallic compounds persist in modified form in the liquid. It seems possible also that what amounts to a form of cybotaxis is present, the compounds, as it were, continually forming and dissociating. A few eutectic alloys have also been investigated. The results would seem to indicate the possibility that there is some tendency for the eutectic components to separate in the liquid, particularly near the freezing point; that is, the structure of the solid alloy is to a certain extent 'foreshadowed' in the liquid. Again, what amounts to a form of cybotaxis, continual intermingling and separation of the eutectic components, seems possible.

It is evident that much work remains to be done. The experimental difficulties, quite apart from the difficulties of interpretation, are of course very great. Nevertheless, considering that the vast majority of metals and alloys used in industry start their existence, so to speak, in the liquid form, and that the process of freezing, as in casting, etc., is still so imperfectly understood, it would seem that there is here a useful line of fundamental research waiting to be developed.

OBITUARIES

Sir Arthur Hill, K.C.M.G., F.R.S.

THE tragic death of Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, in a riding accident on November 3, is not only a disaster for the Gardens, but also a great loss to the many societies, institutions and Government departments of which he was the chief representative of official botany for Great Britain. The twenty-odd years during which he was director saw a tremendous advance in the progress of botanical science in all its branches, and it was natural that Kew should play a prominent part in many of the activities characteristic of this period.

Arthur William Hill was born on October 11, 1875, and was the only son of Daniel Hill, of Watford. He was educated at Marlborough and at King's College, Cambridge, where he obtained a first class in both Part I and Part II of the Natural Sciences Tripos, and later took the degree of Sc.D. He was elected a fellow of King's College in 1901 and became dean in 1907, and since 1932 had been an honorary fellow. He was University lecturer in botany from 1905 until 1907. During the War of 1914–18 he was placed on the special list as adviser on horticulture to the Imperial War Graves Commission and held the rank of Captain from 1917. He was elected a fellow of the Linnean Society in 1908 and a fellow of the Royal Society in 1920. In 1926 he received the honour of C.M.G., and that of K.C.M.G. in 1931.

Hill was attracted to botany by a classical master at his school, the late Edward Meyrick, F.R.S., who was also an enthusiastic naturalist. At Cambridge he came under the inspiring genius of Marshall Ward, and later had the advantage of assisting Walter Gardiner in his work on the continuity of the protoplasm between adjacent plant-cells. His admiration for Gardiner's manipulative skill comes out in the obituary notices he has so recently written (see NATURE of October 18, p. 462). Hill continued this line of research independently, and his contributions, "The Histology of the Sieve-tubes of Pinus" (1901), and "The Histology of the Sieve-tubes of the Angiosperms" (1906), were two of his most important papers and may be regarded as the classic English accounts in this line of investigation.

After taking part in the Bisiker expedition to Iceland, Hill visited the high Andes of Peru and Bolivia in 1903 and this expedition probably made a greater impression on him than all the rest of his world-wide travels. He was particularly struck by the dwarf rosette and cushion plants—a modification displayed in very many families—which are abundant on the Andes, and of these he selected after his return the members of the Malvaceæ, with their remarkable variation in leaf-form, as a subject for detailed investigation. On these he published, some years later, "An Account of the Acaulescent Species of *Malvastrum*" and "A Revision of the Genus *Nototriche*". Many new species of these curious plants have since been discovered, and Hill, who never ceased to be fascinated by them, was planning at the time of his death an entirely new revision of the genus Nototriche to be illustrated by an elaborate series of drawings.

The appointment to Kew as assistant director under Sir David Prain was made in 1907. Hill was allotted a number of routine duties including the editorship of the *Kew Bulletin*, but in spite of these he was able to continue research and he published several taxonomic revisions and other papers. He took a share in the preparation of the great African Floras published from Kew, namely "The Flora Capensis" and "The Flora of Tropical Africa". For both of these he elaborated the difficult family Santalaceæ, which entailed careful dissection of small and inconspicuous flowers, and for "The Flora Capensis" he prepared (in collaboration with Prain) the article on the Gentianaceæ.

On Sir David Prain's retirement in 1922, Hill became director. Some years after his appointment he was successful in obtaining what was to prove of immense value to Kew for the strengthening of ties and the broadening of outlook, namely additional funds and facilities for travel by members of the scientific staff. These came in the form of grants from the Empire Marketing Board. In this enterprise he was stimulated and assisted by the boundless energy of T. F. Chipp who had succeeded him as assistant director. Hill himself took full advantage of the opportunity and visited Australia, New Zealand and Malaya, and, on another occasion, South Africa and Rhodesia, after which he attended the Conference of Directors of Agriculture of East Africa held at Amani in Tanganyika and visited Kenya and Uganda. In all these tours he was able to promote the study of the native flora and vegetation and to improve the relations which Kew already had with Government departments and herbaria throughout the Empire. The result of his visits and of those of the scientific staff led, among other things, to an enormous increase in the amount of material reaching the Herbarium for identification. With the aid of grants from the Marketing Board, additional staff was recruited; but to this day a great accumulation remains to be worked out. The two wings composing the Herbarium were already crowded to excess and after repeated attempts, extending over several years, Hill succeeded in obtaining sanction for the erection of a new wing.

A very successful enterprise which he inaugurated in association with the Forestry Commission was the acquisition of about fifty acres of land at Bedgebury for the purpose of forming a national collection of conifers, especially of those genera which did not flourish at Kew. His active support of the transplant experiments and genetical work carried out at Potterne showed further his sympathy in branches of botany which were not in his own line.

The Kew tradition of providing Colonial Floras was fully maintained under Hill's directorate. The publication of the Gramineæ for the unfinished

"Flora of Tropical Africa" was continued and an entirely new work "The Flora of West Tropical Africa" was initiated and completed. His interests were, however, not confined to the continent of Africa. Of the Indian Floras, he supervised the publication of much of the "Flora of the Madras Presidency" and was recently in correspondence as to the preparation of a final part of the "Flora of the Upper Gangetic Plain". His visit to Trinidad had given him an interest in the vegetation of the West Indies and under his sponsorship also it was arranged in 1928 that the drafts of the new Flora of Trinidad and Tobago should be checked at Kew after preparation in the Colony, and he had himself during the last few years prepared the accounts of certain families—the Sapotaceæ and Convolvulaceæ among others. Repeated attempts to secure funds for a Flora of British Guiana were unsuccessful, but Hill greatly stimulated the study of the flora of this Colony by arranging for an expert systematist from the Herbarium staff to pay visits there, and a number of papers on the flora have already appeared.

Although Hill worked on systematic problems he was not attracted to taxonomy for its own sake and still less when it involved investigation into past history or the unravelling of involved nomenclature and botanical errors. Taxonomy appealed to him as the arrangement of the phenomena presented by morphology. The cushion plants of the Andes, the curious aquatic umbellifer Lilæopsis, the bulbous species of Peperomia, the trimorphism in the flowers of *Oxalis tuberosa*, or the strange development of the basal auricles or the leaves of a southern Caltha, attracted him instantly and led sooner or later to the production of papers. His researches on the living plants at Kew also concerned morphology rather than taxonomy, and considering the wealth of material in the Gardens this was a natural and indeed eminently suitable field of research for a director whose interests had to be wide and who could not spend his days in concentrated study in the Herbarium and Library. The problem of the stony endocarp, Dicotyledons with a single or unequal cotyledons and the twisting movement of flowers and leaves are recent examples of his studies. All these papers taken together form a valuable contribution to general morphology and a fitting sequel to the work of his predecessor Thiselton-Dyer. An experimental turn of mind and an interest in physiology are shown also in not a few of his writings, and during recent years he went to great trouble to initiate and supervise experiments on purifying the air in greenhouses and providing illumination to counteract the adverse effects of London fog, experiments which unfortunately had to cease on account of the War.

As president (1930) of Section K of the British Association Hill chose as the subject of his address "Present-day Problems in Taxonomic and Economic Botany". Another important public lecture was that delivered before the International Congress of Plant Sciences at Ithaca in 1926, when he spoke on "Antarctica and Problems in Geographical Distribution". His address to the first Imperial Botanical Conference in 1924 urging the need of a complete botanical survey of the Empire was opportune and noteworthy.

To the Gardens themselves Hill became deeply attached, and he carried out a number of improvements, some of them being on a considerable scale. His highly developed artistic sense was revealed in all these changes as it was also in his horticultural interests generally. He served on the Council of the Royal Horticultural Society and on many of its committees, and, since 1934, had edited the *Botanical Magazine* for the Society. In 1919 he edited the interesting memoir of that great horticulturist Canon Henry Nicholson Ellacombe, of Bitton. He worked regularly with his own hands in his private garden and was always ready to encourage the good amateur.

Riding was a relaxation he greatly enjoyed and had retained from his Cambridge days. He would often say that so long as he could have a horse and ride a bicycle he would not buy a car. He was a man of very high and rigid principles and a devout churchman. He had an intense interest in church architecture and was a generous benefactor to the church he regularly attended. A love and appreciation of art and music also found a place in his busy life, while the genial hospitality of his official residence was known to botanists and others from all parts of the world. Fastidious in his tastes and often somewhat aloof, he was truly sympathetic and kind-hearted. His intimate friends were few and these held him in the deepest regard and affection.

For Kew the loss is very great. He held the balance almost perfectly between the interests of the Gardens and those of the Herbarium, Museums and Laboratory, while the versatility of his nature made him capable of taking interest in every aspect of the Gardens' administration. A. D. COTTON.

AMONG the many activities of the late Sir Arthur Hill not the least was his interest in the botanical welfare of the Dominions and Colonies. In the early days he had made a collecting tour of the high Andean regions of Peru and Bolivia, and this seems to have stimulated his interest in travel, for in after years he visited many widely separated regions and consequently acquired a vast knowledge of tropical and subtropical flora. His first visit to the West Indies was made in 1912, when he represented Kew at the Eighth West Indian Agricultural Conference at Trinidad; afterwards he visited Barbados and the Windward and Leeward Islands. He visited botanic gardens in the various islands, and while appreciating the many fine exotic species, deplored the neglect of native plants in the collections. He was specially impressed with the early work on cacao grafting, and urged continued work on more intensive lines. Incidentally it may be remarked that this work has been developed and is one of the main items on the programme of cacao research which has been undertaken with gratifying results by the Imperial College of Tropical Agriculture.

Sir Arthur Hill was keenly interested in agricultural

education, and was one of the original governors of the Imperial College of Tropical Agriculture, being nominated by the Secretary of State for the Colonies. He visited Trinidad again in 1919 with Sir Arthur Shipley, to attend the opening ceremony of the West Indian Agricultural College at St. Augustine, Trinidad, an institution which received a Royal Charter two years later and changed its name to its present designation. He afterwards visited Jamaica, and it was during this visit that he became impressed with the seriousness of the threat to the banana industry, which was beginning to suffer severely from the ravages of disease. It was due to his proposals that the Banana Research Scheme, also centred at the Imperial College, came into being. He was firmly of the opinion that the problem could best be solved by breeding strains resistant to Panama disease.

In 1921 he visited the Cameroons to advise the Secretary of State on the Botanic Gardens at Victoria, and he afterwards toured Nigeria to study native agriculture. He attended the International Congress of Plant Sciences at Ithaca in 1926, and then visited California and British Columbia. His theme was always the necessity for preserving the native flora in suitable reservations or parks. Official tours were made during 1927–28 to Australia, New Zealand, Malaya and Ceylon, and the Botanic Gardens at Buitenzorg in Java were also visited. In all these places he was consulted on matters connected with herbaria, museums and botanic gardens, and the result of these visits was to establish closer liaison with Kew. One of the results of the tour was a scheme for the temporary exchange of botanists from Kew with those from Australia, and a somewhat similar system was devised for India and the Union of South Africa. The winter of 1930–31 was occupied in a visit to South Africa at the invitation of the Government of the Union. Here again he stressed the need for botanical reserves, especially in connexion with the preservation of the native flora. He deplored the extensive planting of the slopes of Table Mountain with exotics, and expressed the view that it should be kept sacred as a reserve for the native flora. On his return he visited East Africa and attended an agricultural conference at Amani, when he took the opportunity of reviewing the botanical work that was being undertaken by the Agricultural Research Institute.

He had been appointed a member of the Colonial Advisory Council of Agriculture and Animal Health when that body was first constituted. His unique knowledge of conditions in so many of the Colonies proved of great value, and during the period of construction that followed the end of the War of 1914–18 he served on many committees and conferences dealing with agricultural improvement in the Colonies. It is rather remarkable that the last meeting he actually attended before his death was a committee of the council which was dealing with agricultural education in the Colonies.

Sir Arthur had long wanted to visit India, and his chance came in 1938 when he visited Calcutta as an official representative of the British Association to the Indian Science Congress. It was a real *tour de force* and he received a great welcome from the Royal Botanic Gardens, Calcutta, the universities and the cinchona plantations and other gardens which were staffed by Kew-trained men. His last foreign tour was in March 1939 when he was an official representative of H.M. Government at the Eighth International Congress of Tropical and Subtropical Agriculture. The meetings were held at Tripoli, and afterwards he took the opportunity of visiting the new Fascist Colonies in Cyrenaica. In discussing the matter after his return he remarked that the work of reclaiming the desert was of great interest and value, but that the cost must prove uneconomical.

Kew has been the source of inspiration to all botanists in the Empire for the last hundred years, and Hill's many tours and his personal correspondence did much to preserve the links that tie it to so many of the botanical institutions that have sprung up overseas.

He was always particularly glad to see old Kew men when they were home on leave from their overseas stations, and his advice was valued. The advent of the present War saddened his outlook, and every bomb that fell on the Gardens was regarded more or less as an act of sacrilege. Throughout this period, however, he carried on bravely with a much depleted staff, and looked forward to the future with serenity. His private benefactions were numerous—how numerous few people can guess—but the people of Kew realize their loss. A manner which was often rather abrupt hid the kindliest nature and a heart of gold. His passing will cause a big break in the story of the Royal Botanic Gardens. He had worked there for thirty-four years either as assistant director or director, and during the last few months had spent much time in compiling a full and detailed history of the Gardens.

Geoffrey Evans.

The broad zone of common interests shared by the Royal Botanic Gardens and the Royal Horticultural Society afforded Sir Arthur Hill, as director of Kew, ample opportunity for rendering service invaluable to the Society. For many years, from 1919 onwards in fact, Sir Arthur served on the Society's Council and on several of its committees, thus he was a regular visitor to the Wisley Gardens and Laboratories.

To his unfailing generosity the fellows of the Society are largely indebted for the collection of plants in the Wisley temperate house. A more recent gift of uncommon hardy shrubs materially assisted in the planting of the newly acquired Battleston Hill.

The members of the Wisley staff will not fail to remember his kind concern with all aspects of their scientific work and also with their welfare; nor will those concerned with taxonomy and nomenclature forget his constant courtesy in so frequently assisting them by placing the facilities of the Kew Herbarium at their disposal.

Away from his administrative duties and cares, Sir Arthur thoroughly enjoyed his quiet but critical contemplation of the Society's decorative plants—

species, varieties and garden hybrids; and there is no doubt that he too appreciated an epicurean discussion of the virtues and failings of apples old and new. He frequently aroused the interest and envious admiration of professional and amateur fruit growers alike, less fortunate perhaps than he was in regard to frost damage to their trees, when he described the quality and quantity of the crops he gathered in his own garden.

When in South America, Sir Arthur noticed the three coloured forms of the oca (*Oxalis tuberosa*). He wished to study the relationship between the tuber colour and the structure of the flowers which proved very difficult to obtain in Great Britain, but by controlling the period of light we found it possible to obtain a few flowers at Wisley for comparison with other material grown at very high altitudes in central Europe.

During the last seven years Sir Arthur edited *Curtis's Botanical Magazine*, published by the Society, thereby maintaining the tradition so firmly established by Sir Joseph Hooker during his forty years editorship. It is deeply regretted that these activities have been so tragically terminated, but one records with gratitude the high value to us of his interest and work. M. A. H. TINCKER.

FOR nineteen years Sir Arthur Hill held with outstanding success an official position which developments of the science of botany have made very exacting. In the middle of last century the expansion of the Empire had confirmed the commanding position of Great Britain in systematic botany: Kew was its centre, and the Hookers its leading figures. But the study of botany in the universities was at a low ebb. The publication of the "Origin of Species" led to that revival of interest in the morphology and physiology of animals and plants which sprang up at South Kensington under Huxley and Thiselton-Dyer.

Hill did not himself participate in the change, for he was then too young. Even Gardiner, under whose guidance at Cambridge he acquired the finest microscopical technique, was a product rather than an agent in the revival of botanical study there in the 'seventies. Thus Hill passed on imbued with the 'new botany' already widely current. As assistant director of Kew he had under Prain an unrivalled opportunity for systematic study. The result was that, when appointed as director after Prain's retirement, he was able to give to the botanists of his time advice and help in both branches. His genial personality made him a friend to all inquirers. In fact, he was for many years an ever-ready adviser for students, whether in the garden, the laboratory or the herbarium.

Others are giving detailed accounts of Hill's life, and its widespread Imperial activities. Here a very old friend has pleasure in telling how fully he maintained the old systematic tradition of Kew, while promoting and expanding its adaptation in the widening scope of the science to meet the needs of a later time. F. O. BOWER.

OTHERS will have expressed their appreciation of Sir Arthur Hill's eminence as a botanist; I knew him best as a man and a gardener. What was most distinctive of him was the very wide circle of friends to whom he was "Arthur". He had a gift for friendship and as his official position at Kew brought him into contact with the lovers of gardens and trees, not only in Great Britain but also all over the English-speaking world, these acquaintances ripened easily and at once into something warmer and more intimate.

He knew plants as few men did; he appreciated their points of interest and he liked to draw others into his own appreciations; I remember him perhaps at his happiest when at certain dinners, where gardeners or men of science met to exchange experiences, he was explaining the special features of things he had brought from Kew. This ease of intercourse was of great value to him officially. As a Government Department Kew Gardens belongs to the Ministry of Agriculture, its expenditure requires the sanction of the Treasury, its buildings, glass houses and the like have to be dealt with by the Office of Works. It is easy for any of these great offices to adopt an unsympathetic attitude to a relatively small spending organization which does not lie within the great stream of public affairs, but Hill's tact and friendliness smoothed the way to many improvements in the Gardens and in the conditions of work of its extensive staff.

Hill's contacts with gardening were many and various; he was closely-associated with the Royal Horticultural Society, from the council of which he only retired to edit on their behalf *Curtis's Botanical Magazine*, that record of new plants running back for more than a century and a half. He was long a member of the council of the John Innes Horticultural Institution, in the affairs of which his quiet judgment was always of value. No record of Hill would be complete that ignored his devotion to the Church and its social work; my last business with him was concerned with the education of two boys in difficult circumstances who had been brought to his notice through the Church.

Hill was not a player of games, his recreations were conversation and riding, and if the latter did bring him down at last, his end came instantaneously in the full tide of his enjoyment—and what better end can any man desire? A. D. HALL.

ONE evening early in 1907 Arthur Hill called at my house in Cambridge to discuss the prospects of an appointment of which he had just heard. The post in question was that of assistant director of the Royal Botanic Gardens, Kew, in itself an attractive one; but Hill was much attached to Cambridge and to King's, and the thought of leaving was disturbing. I knew of these Cambridge attachments, but I knew, too, something of the prospects offered by Kew under Sir David Prain, then recently returned from India, and I had no hesitation in strongly advising Hill to accept the London post.

I have never had any doubt, nor I feel sure had he, that this advice was right. The more one saw of Hill and of Kew, the plainer it was how well man and post were assorted. Of this, visitors to Kew had much evidence in the condition of the Gardens; but it was not so much from the broad general picture as seen by the public as from minor indications that Hill's deep love of Kew and all that Kew stands for were to be gained. Watch him, for example, exult as a friend fails to detect on some smooth lawn the spot where a month or two before a bomb-crater yawned; or, again, note his pleasure over the complete recovery of some tropical plant, saved from destruction by the temporary repairs effected to badly damaged glass. Or accompany him on some Sunday afternoon to the loose boxes in which were two fine teams of Suffolk horses waiting impatiently for the carrots which clearly were expected as soon as Hill was seen. Trivial things these, but pointers to conditions that make the duties of a post not merely matters to be attended to, but a worth-while job.

In recent years my own association with Hill arose chiefly from the fact that we were both members of the Council of the John Innes Horticultural Institution. Here his Kew experience was most helpful to Hill's colleagues, and his loss will be much felt.

Thomas H. Middleton.

My first recollection of Arthur Hill is of seeing him riding through the streets of Cambridge. My next is of attending six lectures he gave on Algæ in the Easter Term of 1906 when he shared the elementary course with R. H. Biffen and A. C. Seward owing to the illness of Marshall Ward. By that time he had travelled to Iceland and the Andes and had written short accounts of their vegetation; his chief interest was, however, in histology, his work on protoplasmic connexions being of fundamental importance. The following year he left for Kew.

I do not think that Hill seriously concerned himself with the practice of systematic botany. He had no flair for herbarium work possibly because the new order in botanical ideas prevalent in his student days apparently regarded such studies as worthless. He was, however, a keen observer of growing plants and attributed his interest in natural history generally to the stimulus of his Marlborough days. He published a number of small systematic monographs but was attracted mainly by general problems of taxonomy, particularly the origin of Monocotyledons, which interested him to the end. The plants growing at Kew provided him with material for a steady flow of notes and papers on morphology and development; at the last meeting of the Linnean Society he exhibited a Streptocarpus with cleistogamous flowers.

The Royal Botanic Gardens were to Hill almost a religion. No improvement he carried out, so far as I recollect, did anything but enhance their beauty.

After the War of 1914–18 there was money available for schemes of imperial development, and Hill, always keen on travel, characteristically made full use of his opportunities. He believed in the eminence and prestige of Kew and pushed his belief to the utmost. The Kew collections benefited from the contacts he made and he himself gained a wide first-hand knowledge of botanical conditions overseas, and in the years that followed continued and extended his interests. The tragedy of his death is that it should have occurred now, for his experience would have been invaluable in the reconstructions that are inevitable when peace ensues.

Arthur Hill was very much the boy at heart. He was the kindest of men, showing an understanding sympathy not only in the written word but also in unostentatious generosity to those in need.

J. Ramsbottom.

Mr. M. Ussishkin

Palestine and the Jewish people have suffered a great loss through the death in Jerusalem at the age of seventy-eight of Menachem Ussishkin. He was known as "the grand old man of Zionism", and his influence was felt in every Jewish activity in Palestine. But he had a particular love for the soil of Palestine, and for the last eighteen years of his life devoted himself to the buying of land in Palestine as the collective property of the Jewish people.

Ussishkin was closely associated with the Hebrew University in Jerusalem, which was inaugurated by the late Lord Balfour in 1925. He was a member of its Board of Governors, and attended the meetings of this body not only in Palestine, but also in many different centres in Europe. He was also a member of the executive committee of the University in Jerusalem. His enthusiasm for every branch of university life, and in particular his close personal contacts with successive generations of students, gave him a great influence on the development of the Hebrew University, which now has 1,100 students with a staff of more than 125 professors and lecturers.

Ussishkin's early training in his native land, Russia, was as an engineer, but he very soon became a leading figure in the movement for the return of the Jews to Palestine, and later in the Zionist movement. He was particularly ardent in the support of the movement to revive Hebrew as a language of daily intercourse, and as a language of literary and scientific writing.

Ussishkin's most obvious characteristics were indomitable courage and uncompromising adherence to principles. At the same time he was the kindest and the most courteous of men. When he died, 50,000 people followed his coffin to the grave, for Palestine had lost in him its greatest figure.

We regret to announce the following deaths:

Mr. V. M. Foster, geologist in the U.S. Geological Survey, on September 2, aged thirty-seven.

Prof. A. C. Fraser, professor of plant breeding in Cornell University, on September 17, aged fifty-one.

Prof. E. E. Maar, professor of the history of medicine in the University of Copenhagen, aged sixty-eight.

Mr. J. D. Martin, assistant conservator of forests, Northern Rhodesia, on November 10, aged thirty-two.

NEWS AND VIEWS

Royal Society Medallists

HIS MAJESTY THE KING has been graciously pleased to approve the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year, as follows:

Prof. E. A. Milne, Rouse Ball professor of mathematics in the University of Oxford, for his researches on the atmospheres of the earth and the sun, on the internal constitution of the stars, and on the theory of relativity;

Prof. E. L. Kennaway, professor of experimental pathology in the University of London, and director of the Chester Beatty Research Institute, Royal Cancer Hospital (Free), for his investigations on production of cancer by synthetic substances.

The following awards of medals have been made by the President and Council of the Royal Society:

Copley Medal to Sir Thomas Lewis, physician-in-charge of the Department of Clinical Research, University College Hospital, London, for his experimental researches in the clinic and the laboratory, on the heart and the circulation, and their disorders.

Davy Medal to Dr. H. D. Dakin, director of the Research Laboratory, Merck Institute of Therapeutic Research, Scarborough-on-Hudson, New York, for his work as a pioneer in biochemical research and especially because of his fundamental contributions to the study of intermediate metabolism.

Hughes Medal to Prof. N. F. Mott, Melville Wills professor of theoretical physics in the University of Bristol, for his fertile application of the principles of quantum theory to many branches of physics, especially in the fields of nuclear and collision theory, in the theory of metals, and in the theory of photographic emulsions.

The Student Martyrs of Prague

NOVEMBER 17 was the second anniversary of the shooting by the Germans in Prague of ten Czechoslovak students, and was observed as an International Day of Students. On November 16 a commemoration meeting was held in the Caxton Hall, London, and was attended by students from more than twenty nations. The following stimulating declaration was made and has since been broadcast to students in all parts of the world: "We declare that November 17 shall always be for us not only the day on which free students everywhere shall pay tribute to their dead Czechoslovak fellows, and to those who are still in prison and concentration camps, but it shall also be the day when we will remember with fervent determination the ideals for which they suffered and are suffering. We free students give our solemn promise to do all that is in our power to crush this brutal Fascist violence, and to dedicate ourselves to preventing its renewal in any shape or form."

The persecution of students and intellectuals has not been confined to the Czechoslovak peoples; neither is it ended. The Yugoslav Government in London has recently announced that ruthless atrocities against the civil population have taken place in Kragujevac, in Central Serbia. The Germans are stated to have shot in that town 2,300 civilians in the last two weeks as a reprisal for the killing of 26 German soldiers. A large number of intellectuals have been taken out of their homes and shot. The Germans, not being able to find enough hostages among the adult population, have arrested hundreds of students between the ages of sixteen and eighteen, and some of these have already been executed.

Men of Science and the National War Effort

IN view of the widespread feeling that our scientific and technical resources are not being used to the best advantage in the national effort, that much valuable knowledge and experience is being wasted through sufficient responsibility not being given to scientific workers, and that a number of scientific workers have grievances, caused by irregular conditions of working, which unnecessarily discourage them from putting out their maximum effort, the Association of Scientific Workers is calling a series of regional conferences at which men of science, engineers, technicians and laboratory assistants can discuss their problems and decide on appropriate action. Much of the responsibility for improvement of the situation must be borne by all classes of scientific workers. It is therefore to be hoped that the fullest co-operation of all concerned will be obtained.

At the first of these conferences, which will be held in Birmingham on December 6 from 2.30 until 5.30 p.m., at the Royal Society of Artists, New Street, Birmingham, the discussions will be opened by Mr. D. P. Riley, who will speak on "The Responsibilities of the Scientist to the Community"; Mr. J. A. Henley, on "The Position of the Scientist in Industry"; and Mr. E. D. Swann on "The Rôle of the Scientist in the National Effort". The meeting will be open to all scientific workers.

Committee on Producer Gas Fuel

THE Secretary for Mines has asked the committee which considered low-temperature carbonization processes last year to reassemble, and to examine the sources of fuel for producer gas vehicles, to estimate the quantities that could be made available at present, and to report on the measures that would be required to increase the supplies if necessary. The committee will also inquire whether the development of the peat resources of Great Britain would make any useful contribution to the supplies of domestic fuel in the present coal situation. The constitution of the committee is: Lord Henley (chairman); Mr. Gordon Macdonald, M.P.; Dr. W. H. Mills, lately reader in

stereo-chemistry in the University of Cambridge; Mr. F. B. Richards, chairman of Woodall-Duckham Company; Mr. J. Shearman, road motor engineer, L.M.S. Railway; Mr. T. E. B. Young, general manager, Bolsover Colliery Company; Mr. W. A. Macfarlane (secretary); and Dr. F. S. Sinnatt, director of fuel research (Department of Scientific and Industrial Research), and Mr. J. A. Brook, Mines Department, assessors.

Bibliography of the British Fauna and Flora

ONE of the difficulties facing anyone wishing to study a group of British animals or plants is that of obtaining reliable information on books and papers that will be helpful in their identification. The Association for the Study of Systematics in Relation to General Biology, one of the aims of which is to encourage wider and more serious studies in systematics, therefore decided to compile a bibliography on the subject. This laborious task has been accomplished with the help of various experts, mainly of the British Museum (Natural History) and the Royal Botanic Gardens, Kew, and the book is expected to appear shortly. It contains systematically classified lists of books and papers which may be consulted when studying any given group of British animals or plants. Brief notes on the character and contents of each book and paper are given, so that an idea can be formed as to whether it answers any particular requirements. The whole forms a most useful guide for systematic studies and is certain to achieve its purpose of stimulating scientific interest in the British fauna and flora. Further information can be obtained from the Secretary of the Society at the British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7.

American Foreign Policy

UNDER the title "American Foreign Policy" Prof. D. W. Brogan has given (Oxford Pamphlets on World Affairs, No. 50. 4*d.* net) a brilliant and concise interpretation of the traditional outlook of the United States on world affairs, the policy which she has followed in recent years and the machinery by which that policy is carried out. The pamphlet should make a valuable contribution to that mutual understanding by the two peoples upon which alone effective collaboration can be based. What Prof. Brogan has to say about the United States as a missionary of freedom and of American sympathy with democracy, no less than his explanation of the machinery of American foreign policy and of the real meaning of the Monroe doctrine, should go far to remove some of the difficulties which the ordinary citizen of Great Britain experiences in understanding, and still more in reconciling, the high moral line taken in foreign affairs by American public opinion, and the much more realistic attitude of the Administration. In this lucid account, written with admirable detachment, particular attention is given to the development of policy since 1918, including the "Good-Neighbour" policy, the reactions of the rise of Nazism and the collapse of France on the Monroe doctrine and its application or interpretation and the influence of the war debts on American opinion. Prof. Brogan has rendered real service to Anglo-American collaboration and all that it involves by this admirable exposition of the 'neutrality legislation' and the factors weakening extreme isolationism and bringing the two democracies to such a declaration of common policy as that contained in the Atlantic Charter.

The Genetical Society of Great Britain

DURING the first year of the War the British Genetical Society, which has a membership of 146, held only its annual meeting. From the summer of 1941 it may be said, however, to have resumed its normal activities. Two meetings have been held, at the Rothamsted Experimental Station and at Oxford. On each occasion papers were read and members demonstrated a considerable series of exhibits. Although winter meetings are still impossible, it is hoped to commence a full programme next year with a meeting in the early spring. The present officers of the Society are: *President*, Prof. R. A. Fisher; *Vice-Presidents*, Dr. C. D. Darlington, Prof. Julian Huxley, Dr. R. N. Salaman; *Treasurer*, E. R. Saunders; *Secretaries*, Dr. K. Mather, Dr. E. B. Ford.

Announcements

ACCORDING to a Dutch correspondent of *The Times*, the German authorities in Holland have closed the University of Leyden. After November 20 no examinations are being held there, but the students will be allowed to sit for examinations at other Netherlands universities, and will be admitted to German ones. Lectures at Leyden were discontinued a long time ago (see NATURE of February 8, p. 161).

THE following appointments in the Colonial Service have recently been made: E. D. Bumpus, agricultural superintendent, Nigeria; A. E. Kerr, assistant Government chemist, Trinidad; J. E. Cousens, assistant conservator of forests, Malaya; A. P. D. Jones, assistant conservator of forests, Nigeria; J. J. Laurie, assistant conservator of forests, Gold Coast; G. H. Thompson, assistant conservator of forests, Gold Coast; R. J. Osborne, surveyor, Uganda; D. Westwood, agricultural officer, Gold Coast; Dr. A. W. R. Joachim (agricultural chemist), divisional and research staff officer, Ceylon.

A CENTRAL sales branch has been organized for all work connected with subscriptions, sales and distribution of the journals and other publications of the majority of the Imperial Agricultural Bureaux; its offices are at the Agricultural Research Building, Penglais, Aberystwyth. The only publications not dealt with by the central sales branch are those of the Imperial Institute of Entomology (Assistant Director, Imperial Institute of Entomology, 41, Queen's Gate, London, S.W.7) and the Imperial Mycological Institute (Director, Imperial Mycological Institute, Ferry Lane, Kew, Surrey), and *Nutrition Abstracts and Reviews* (Secretary, Imperial Bureau of Animal Nutrition, Rowett Institute, Bucksburn, Aberdeen).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Auxin Production during the Development of the Grain of Cereals

IT has been shown by Gregory and Purvis[1,2], Kostjucenko and Zarubailo[3,4] and others that the developing grain can be vernalized in the ear during the period of embryo formation. It has further been suggested by Cholodny[5,6,7] and others that auxin or a similar hormone plays an important part in the vernalization process. It appeared important therefore to undertake a direct study of the auxin relations in developing grain of both spring and winter varieties of cereals. The work was carried out with pure-line spring and winter varieties of Petkus rye. At known intervals after anthesis grains were removed from the ears and the auxin content determined by Went's coleoptile method. The hormone was obtained in two ways: (1) direct diffusion into agar, (2) extraction of the ground fresh material in water and subsequent concentration under reduced pressure. Relevant details of the methods will be published elsewhere.

It was found that no diffusible or extractable hormone appears in the developing carpel until two weeks after anthesis, but from this time forward rapid production of auxin occurs reaching a maximum at some 5–6 weeks after anthesis. The maximum is simultaneous with the stage of complete differentiation of the embryo. In the interval mentioned the auxin content has increased nearly a hundredfold. The data are presented in the accompanying table and refer to (*a*) winter rye grown in the field, (*b*) winter rye grown in sand culture with controlled nutrition, (*c*) spring rye. No consistent differences are seen between the varieties; so that the different behaviour of these types with regard to their low temperature requirements for flowering cannot be accounted for on the basis of auxin production during development.

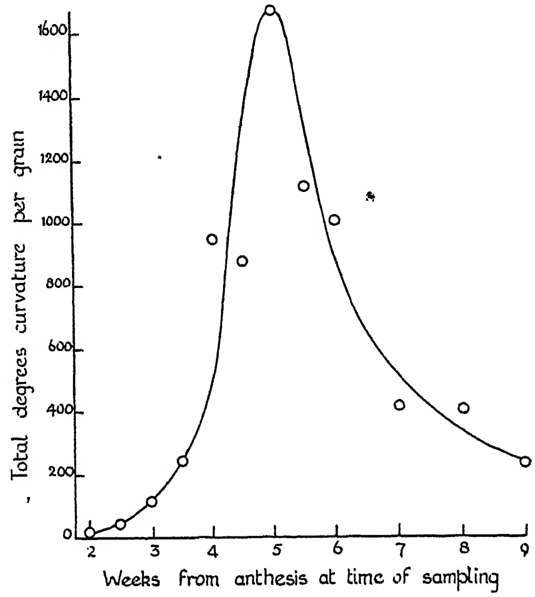
The mean values are presented graphically in the figure. It will be noted that after the maximum hormone content has been attained a rapid fall follows, so that in the completely mature grain the hormone content is so low that the diffusion method fails to detect its presence, though by extraction it can still be demonstrated. The apparent disappearance of the hormone is related closely to desiccation of the grain and has been found to be associated with its germinating capacity. It is worth noting that the hormone is confined to the endosperm and at no time

Auxin Content per Grain at Various Stated Times after Anthesis Measured by Extraction Method.

Weeks from anthesis	Winter rye in field	Winter rye in sand culture	Spring rye
2	18	—	—
2·5	—	45	35
3	96	122	116
3·5	—	240	—
4	865, 810	768	1210, 1120
4·5	—	877	—
5	1419	2301	1260
5·5	—	1113	—
6	357	789	1874
7	270	—	560
8	—	—	402
9	234	—	—

All values given in total degrees curvature per grain

$$= \frac{\text{Mean curvature} \times \text{dilution (c.c.)} \times 100}{\text{Number of grains in sample extracted}}$$



is sufficient auxin present in the embryo to detect it by the methods employed. In view of the low content of auxin in the mature endosperm of rye it may be pointed out that other cereal grains have been examined. The large hormone content of dry maize endosperm first shown by Cholodny has been confirmed. Oats is found to occupy an intermediate place, and diffusible auxin from this grain has been estimated. Wheat and barley resemble rye in that no diffusible auxin could be established.

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Egg-laying of Ducks as an Enforced Relaxation Oscillation

THE formation and deposition of a bird's egg can be described as a relaxation process[1], the egg material being piled up gradually and released suddenly. The sustained production of eggs can then be regarded as a series of relaxation oscillations. In an undisturbed relaxation system discharges take place when the accumulating material (energy) reaches a certain level, but the length of period may change if the stream of material (energy) varies. If a bird were

an undisturbed relaxation system, eggs of fairly constant size would be expected at varying intervals according to the amount of food available. This is not the case in ducks, where eggs of varying size are deposited regularly in the morning on consecutive days, sometimes for months, with pauses of one, seldom two or more days, between each clutch.

Now constant period length and variable amplitude, although foreign to relaxation oscillations, are characteristic of the well-known type of sinoidal oscillation. A duck's egg-laying activity combines features of both types of oscillations. This is due to the synchronizing of an external sinoidal 24-hour rhythm on the relaxation system, as can be shown by the following facts. The eggs of a clutch decrease in weight so that the first egg is usually the heaviest and the last egg the lightest. The differences between the biggest and smallest egg laid by one duck are not great (c. 20 per cent) and extremely small eggs (35 gm.) and big eggs (double-yolked eggs more than 110 gm.) are exceptional.

Tables 1 and 2 show the decrease of egg weight from the beginning to the end of the clutch.

TABLE 1.

The mean deviation from the dam's mean egg weight of 570 eggs according to position in the clutch.

Position of egg in clutch	1	2	3	4	5	6	7
Weight of egg relative to the mean (gm.)	+3·42	+2·54	−0·09	−1·99	−2·41	−2·43	−3·12
Number of eggs	105	105	105	105	70	52	28

TABLE 2.

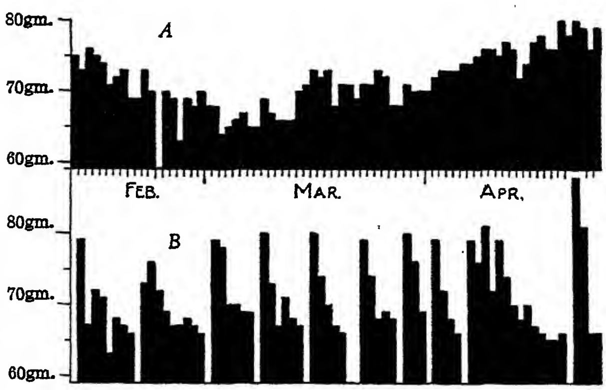
Mean weight of the last five eggs in 161 clutches of at least five eggs, laid by 24 Aylesbury × White Campbell ducks.

Position of egg in clutch	5th last	4th last	3rd last	2nd last	last
Mean weight in gm.	76·04	74·90	73·26	72·79	72·03

Some ducks lay eggs on more than two hundred consecutive days, others pause more frequently. If the egg weights of two such birds are compared, it is seen that the decrease in weight is much more rapid in the latter than in the former (see accompanying figure). It seems that the ovary or oviduct of the former cannot produce enough material completely to replace the egg laid twenty-four hours earlier, and hence the eggs decrease in weight until a limit is reached where no egg is laid at all. During the pause more material is accumulated and so the first eggs of the next clutch are again bigger.

For the occasional occurrence of pauses of two or more days only a historical explanation can be suggested. The wild duck lays two or three clutches of eggs each season, each clutch being separated by a period during which the eggs are brooded and the ducklings reared. Once the laying of a clutch ceases there seems to be some mechanism which delays the resumption of laying. In the domestic duck, which has its eggs removed and is not encouraged to brood, this blocking mechanism is eliminated, but not completely. It may be mentioned that broodiness is known to be inherited in hens[2].

The synchronizing 24-hour rhythm is probably the light rhythm, but it remains to be decided experimentally whether it produces its effect through its action on the endocrines[3,4] or by the determination of feeding periods. A diurnal rhythm of the genital tract has so far only been described for female rats[5].



WEIGHTS OF ALL EGGS LAID BETWEEN FEBRUARY 10 AND APRIL 25, 1931; *A*, BY A DUCK LAYING CONTINUOUSLY; *B*, BY A DUCK LAYING INTERMITTENTLY.

The yearly period also influences egg-laying, the weight of the ducks' eggs increasing during the laying period, as has been recently shown[6]. As can be seen in Table 3, not only heavier eggs, but more eggs are laid as the year goes on and the clutches increase in length. Probably both the stream of assimilated material and the egg-producing organs are influenced by seasonal factors.

TABLE 3.

Mean production of eggs per day, and number of days where no egg was laid. 24 Aylesbury × White Campbell ducks.

Month	Egg per day	Free days in month
October	0·04	29·60
November	0·05	28·37
December	0·09	28·13
January	0·15	26·46
February	0·50	13·58
March	0·75	7·58
April	0·70	8·38
May	0·60	12·25
June	0·37	18·79
July	0·07	28·83

The egg production of ducks as described above shows a close formal resemblance to electro-physiological phenomena, as for example, the normal or pathological action of heart and muscles[7], and to related biorhythmic processes.

I wish to thank Mr. J. M. Rendel for permission to use his data on egg weights.

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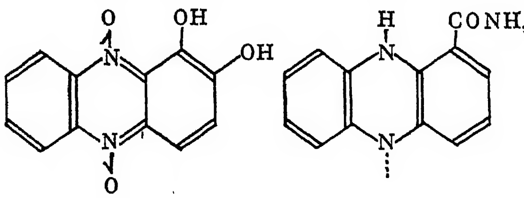
Antibacterial Action of Two Bacterial Products of Known Structure

THE importance of inhibitory compounds in normal living systems, as distinct from their artificial introduction for example, as therapeutic agents, is being increasingly realized. In particular, substances have been isolated from certain micro-organisms which inhibit the growth of other species (for detailed references see Waksman and Woodruff[1]). The structures of the majority of these compounds are not yet known, and in view of their importance as possible therapeutic agents or as models for such agents, the following results with two bacterial pigments of known composition are given.

The pigment of *Chromobacterium iodinum* was isolated and shown to be the N.N′-dioxide of a dihydroxyphenazine (probably I) in 1938.[2]



I II

In connexion with other work in this laboratory, its effect on the growth of *Bact. coli* and *Streptococcus hæmolyticus* was recently investigated. The compound was found differentially inhibitory to a marked degree, and its effect on the growth of one strain each of other organisms was briefly surveyed.

It is seen that approximately 2 µgm./ml. of the pigment prevents visible growth of *S. hæmolyticus* in liquid media; this inhibitory power is of the order of those recorded for the more active of the natural inhibitory substances. Like other substances, its action is greatest against the Gram-positive organisms investigated; the order of susceptibility of the organism is also that of increasing nutritional complexity. Inhibition was also exhibited on solid media: 2 µgm. of the pigment prevented growth of *S. hæmolyticus* within a radius of 1 cm. In growth, *Chr. iodinum* can produce 100 µgm. of pigment per sq. cm.[2].

A synthetic specimen of chlororaphin (II, formulated as a phenazyl[3]) which was prepared in 1934[4] in confirmation of the structure of Kögl and Postowsky[5] was also found inhibitory, but to a lesser degree. Pyocyanin is already known to be inhibitory to bacterial growth and metabolism[6]. Thus the three known types of naturally occurring phenazine compounds, which are all bacterial pigments, can be of functional value to the organisms producing them, by antagonizing the growth of competing organisms.

Inoculum		Medium	Addendum			Duration of inhibition (days)
Organism	Approx. number/5 ml.		Compound	Molarity	µgm./ml.	
Streptococcus hæmolyticus	10^6	Broth	I	8×10^{-6}	1·7	>6
,, ,,	,,	,,	,,	4 or 2×10^{-6}	0·8, 0·4	0
,, ,,	10^3	Amino acids, etc.[8]	,,	8×10^{-6}	1·7	>6
,, ,,	,,	,,	,,	4×10^{-6}	0·8	1
,, ,,	,,	,,	,,	2×10^{-6}	0·4	0
,, ,,	10^6	Broth	II	(suspension)	100	>6
,, ,,	,,	,,	,,	,,	20	0
Staphylococcus aureus	,,	,,	I	2×10^{-4}	43	3
,, ,,	,,	,,	,,	4×10^{-5}	8	2
,, ,,	,,	,,	,,	8×10^{-6}	1·7	0
,, ,,	,,	,,	II	(suspension)	100	<1
Bact. typhosum	,,	,,	I	4 or 2×10^{-4}	85, 43	<1
,, ,,	,,	,,	II	(suspension)	100	<1
Proteus vulgaris	,,	,,	I	8×10^{-4}	170	<1
,, ,,	,,	,,	,,	4×10^{-4}	85	0
,, ,,	10^3	Ammonium lactate, etc.[7]	,,	4×10^{-4}	85	0
,, ,,	10^6	Broth	II	(suspension)	100	0
Bact. coli	10^6	,,	I	4×10^{-4}	85	0
,, ,,	10^3	Ammonium lactate, etc.[7]	II	(suspension)	100	0

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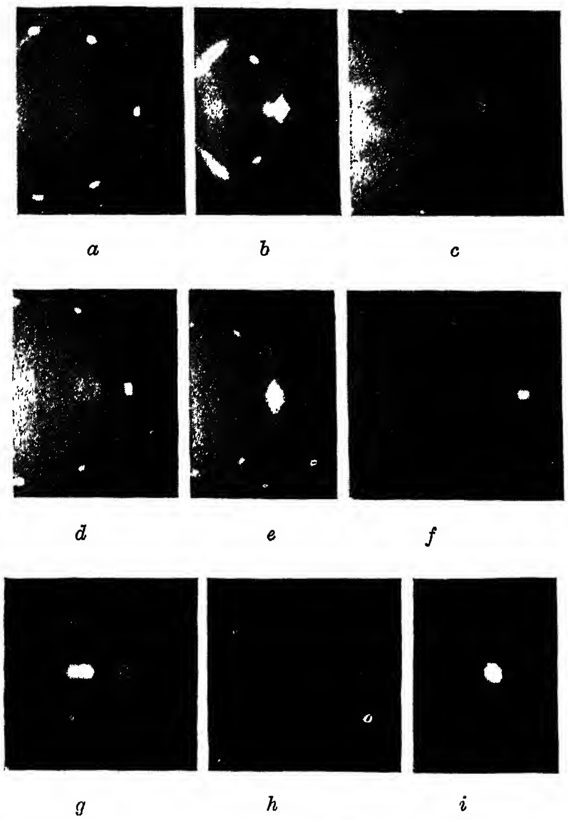
X-Ray Diffuse Reflexions from Sodium and Lithium in Relation to Elastic Anisotropy

WE have photographed the diffuse X-ray reflexions from a number of single crystals of lithium and of sodium at various temperatures. Both show beautiful and elaborate patterns of spots and streaks, which are temperature-sensitive but not structure-sensitive.

Dr. Jahn has recently[1] given an expression for the coherent diffuse scattering from a cubic crystal, based on the Faxén-Waller theory of thermal vibrations. He has applied the formula to sodium, using the known values of the elastic constants to predict the exact detail of the diffusely reflecting region around each reciprocal lattice point. One significant consequence of the theory is that for an elastically anisotropic cubic crystal (that is, when $c_{11} - c_{12} \gtrless 2c_{44}$) the *distribution of reflecting power is different for different reciprocal lattice points* while, other things being equal, the *intensity* at a given distance from any lattice point varies inversely with the absolute values of the elastic constants. A soft, elastically anisotropic substance of simple structure, such as sodium, is therefore ideal for the purpose of testing

the theory. It may be deduced from Dr. Jahn's calculations, for example, that when the $[1\bar{1}0]$ axis is vertical, the copper $K\alpha$ diffuse (110) reflexion from sodium should consist of an approximately square group of four spots when the angle of incidence is considerably less than the appropriate Bragg angle, but that this square closes up and a strong vertical streak (parallel to $[1\bar{1}0]$) appears through it as $\theta \rightleftarrows \theta_{\text{Bragg}}$. The (002) diffuse reflexion should be



(a) Na ; unfiltered, $\theta_{110} = 19{\cdot}9° = \theta_B + 5°$; 3·0 cm.
(b) Na ; unfiltered, $\theta_{110} = 14{\cdot}9° = \theta_B$; 3·0 cm.
(c) Na ; filtered, $\theta_{002} = 23{\cdot}3° = \theta_B + 2°$; 3·0 cm.
(d) Li ; unfiltered, $\theta_{110} = 21{\cdot}1° = \theta_B + 3°$; 3·0 cm.
(e) Li ; filtered, $\theta_{110} = 18{\cdot}1° = \theta_B$; 3·0 cm.
(f) Li ; unfiltered, $\theta_{002} = 28{\cdot}0° = \theta_B + 2°$; 3·0 cm.
(g) Na ; unfiltered, $\theta_{112} = 24{\cdot}4° = \theta_B - 2°$; 3·0 cm.
(h) Na ; unfiltered, $\theta_{112} = 28{\cdot}4° = \theta_B + 2°$; 3·0 cm.
(i) Na ; filtered, $\theta_{002} = 21{\cdot}3° = \theta_B$; 4·0 cm.
Radiation from copper target ; $[1\bar{1}0]$ crystal axis vertical throughout.

quite different, its shape being rather like that of a pair of scissors when $\theta \gtrless \theta_{\text{Bragg}}$, and like a flattened cross when $\theta = \theta_{\text{Bragg}}$. In particular, *the vertical streak parallel* $[1\bar{1}0]$ *should not be present for* (002). This difference is readily explained by the introduction of the elastic anisotropy ; it is a direct consequence of the relationship $c_{11} - c_{12} \ll 2c_{44}$. The disappearance or reversal of sign of the elastic anisotropy would completely change the detail of the individual diffuse spots, even for a crystal of exactly the same crystal structure and unit cell size.

The diffuse spot detail observed for the {110}, {002}, {112}, {130}, {222} planes of sodium, using filtered or unfiltered radiation from a copper target, is just that predicted by the theory. A few examples of Laue photographs taken in various orientations are shown to illustrate this, and exact measurements of the reflecting regions around different reciprocal lattice points will be published later.

The diffuse spot detail for lithium is very similar to that of sodium, and it follows therefore, from X-ray observations alone, that the elastic constants are roughly of the same order of magnitude and anisotropy for the two metals.

It has recently been suggested, on the basis of intensity measurements of powder reflexions, that lithium is not isomorphous with sodium, but crystallizes in a unit cell containing eight Li_2^+ molecules[2]. Laue and rotation photographs of the single crystals do not confirm these suggestions ; on the contrary, all the evidence points to a simple, body-centred cubic, two-atom unit cell of Laue symmetry *m3m*, as correctly assumed by all previous investigators.

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Rigidity and Moisture Hysteresis in Gels

SEVERAL equations have been suggested for the swelling pressure of a hygroscopic gel, of which the best known is the approximate form due to Katz[1]. Porter[2] gives an exact and general equation for the osmotic pressure of a solution. We may, for simplicity, conform to the usual conceptions of swelling pressure and restrict Porter's equation to the case where the only pressure exerted on the solvent is that of its own vapour ; giving

$$\int_{h_1}^{p_1} s\,dp = \int_{h_1}^{h_2} v\,dh \qquad (1)$$

Here p is the applied pressure ; $(p - h_0)$ is the osmotic or swelling pressure required to raise the vapour pressure of the solution to saturation h_0 from its initial value h_1, without change in concentration, s is equal to $\frac{(\partial v)}{(\partial m)_p}$ that is, the change in volume V of the solution per unit mass of solvent removed or added at constant pressure, and V is the specific volume of the solvent vapour under the pressure h. By making V represent the volume of solution containing unit mass of dry solute, m becomes identical with the moisture content defined as the mass of solvent per unit mass of dry solute. Katz's equation may be obtained from this by assuming s to be equal to the specific volume of free water and therefore a constant.

Porter's equation is valuable because the term s stresses the importance of the elastic properties of the solution (that is, its bulk modulus). Now, gels differ from solutions elastically because in addition to the bulk modulus they have rigidity and are partially plastic. They also differ hygroscopically because gels show hysteresis in the $(m ; h)$ isothermal, whereas the $(m ; h)$ curves for solutions are reversible. The purpose of this note is to account for the hysteresis in a gel in terms of its elastic properties.

Using a derivation similar to Porter's, but allowing for shear stresses, we can obtain

$$\int_{p_{k_1}}^{p_{k_2}} s_k dp_k + \int_{p_{n_1}}^{p_{n_2}} s_n dp_n = \int_{h_1}^{h_2} v dh \qquad (2)$$

Here p_{k_0} and p_{n_0} are the hydrostatic and shear components of the directional stresses applied to raise the vapour pressure of the gel to h_0 without change in moisture content, s_k is Porter's s involving only volume change and s_n is V times the change in shear strain per unit change in moisture content.

If the shear components contained in the second integral are elastic, the work done on the gel during adsorption is recoverable on desorption and this process is reversible. If they are plastic, the work done in shear will not be recoverable and an equal work must be done again on desorption, so that the second integral in equation (2) will not change sign.

Once the plastic shear stresses have disappeared p_{k_0} will become equal to Porter's p, so the first integral is independent of plastic shear components. The second integral is always positive so it is evident that $\int vdh$ must be greater on adsorption than on desorption, which is possible if, at any moisture content, the adsorption vapour pressure be greater than the desorption, except at the upper and lower limits of the integrated cycle.

This appears to be a valid explanation of the hysteresis in gels. If the gel is only partially plastic, hysteresis will still occur, but to a smaller extent, so the narrowing of the hysteresis loop at lower vapour pressures is thus explicable in terms of the increasingly elastic behaviour of gels as they become drier.

Some explanations of hysteresis which have been suggested, for example by Zsigmondy[3] or McBain[4], can only be valid for liquid held by capillary forces and cannot account for hysteresis in liquid held by purely molecular sorption on the surfaces of the micelles but, in wood at any rate, there is also evidence of hysteresis in molecular sorption[5]. Urquhart[6] postulates that the swelling of the gel opens up fresh intermicellar surfaces to the sorption, and this is probably true, but it is difficult to see why this effect should not be reversible if sufficient time is given for equilibrium to be established on desorption, unless the deformation is plastic.

The points in favour of the theory of hysteresis here presented are (1) that it depends only on considerations of energy, and (2) that it is accounted for in terms of those elastic properties which distinguish gels from solutions.

The work done in shear will depend on restraints imposed on the gel during moisture changes and will not be a property of the gel itself. The restraints may, however, be inherent in the form in which the gel usually occurs, so evidence is required to show that shear stresses are likely to occur during actual drying or wetting. In wood we have a material which provides definite evidence of shear stresses arising, during natural shrinkage, from the ordered change in shape of the cell structure. During drying, the shrinkage (change in volume per unit volume) of the external dimensions of the hollow cell is considerably less than that of the cell wall material, owing to the restraint imposed by the thin outer sheath (the primary wall) in which the cell is encased, and the area of the void centre therefore becomes a larger proportion of the total cross section. This introduces a shear strain in the cell wall which may be approximately determined. The gel material of other natural fibres is likely to have similar restraints imposed on it during shrinkage. In amorphous gels also, it is probable that shear stresses are introduced because they consist of a network of micelles and it seems unlikely that, by removing water, a reduction in the external dimensions of such a network would be possible without distorting the interlocking meshes. The micelles possess rigidity so some work will be done during this distortion and, if they are partially plastic, the hysteresis must result.

W. W. BARKAS.

Forest Products Research Laboratory,
Princes Risborough,
Aylesbury, Bucks. Oct. 31.

[1] Katz, *Kolloidchem. Beihefte*, 9 (1917).
[2] Porter, *Proc. Roy. Soc., A*, 79, 519 (1907).
[3] Zsigmondy, A., *Anorg. Chem.*, 20, 157 (1909).
[4] McBain, *J. Amer. Chem. Soc.*, 57, 699 (1935).
[5] Barkas, *Trans. Farad. Soc.*, 36, 824 (1940).
[6] Urquhart, *Shirley Inst. Mem.*, 8, 19 (1929).

The Sligo Artefacts

WHEN, in 1927[1], I announced the discovery of the Sligo artefacts, it was asserted, by certain observers, that these specimens were not of human origin, but had been flaked by wave-action which, at times, is very powerful on the west coast of Ireland.

During 1941, fourteen years after my discovery was made, I again visited Sligo, and found that no further specimens, such as I had collected originally, were visible upon the site. Indeed it was obvious that no fracturing by wave-action of the limestone rocks there had taken place since 1927; though, if such fracturing were a reality, the conditions present appeared to be admirably suitable for its successful operation.

The Sligo evidence thus disposes of the claim that wave-action is capable of fracturing hard limestone rock in a manner indistinguishable from intentional human flaking.

J. P. T. BURCHELL.

30 Southwick Street,
London, W.2. Oct. 24.

[1] NATURE, 120, 260 (1927).

Symbiosis of Men and Animals

WHEN Sturt discovered the Darling River he left the following notes, for which I am indebted to Mr. Charles Daley, secretary of the Historical Society :

1. "The channel of the river was from 70 to 80 yards broad, and enclosed an unbroken sheet of water evidently very deep, and literally covered with pelicans and other wild fowl."

2. "Yet as I stood upon its bank at sunset, when not a breath of air existed to break the stillness of the water below me and saw the surface kept in constant agitation by the leaping of fish I doubted whether the river could supply itself so abundantly."

Where now are the pelicans and the fish ? And we may echo, where are the vast numbers of seals that were in Bass Straits ? And where are the fish which were also abundant ? The fish scarcity is entirely man made, and if men act sensibly they can rectify much of the damage ? It will be noted that though pelicans were abundant, so were the fish. There is a symbiosis both with regard to pelicans and fish, and seals and fish. The experience of the Priviloff Islands makes that perfectly clear.

JAMES W. BARRETT.

103-105 Collins Street,
Melbourne, C.1. Aug. 23.

RESEARCH ITEMS

Archæology of Buena Vista Lake, California

The Smithsonian Institution has recently issued a volume on the "Archæological Investigations at Buena Vista Lake, Kern County, California" by Waldo R. Wedel (Bureau of American Ethnology, Bull. 130). Buena Vista Lake lies at the southern end of the great Californian valley which runs roughly north and south inland and parallel to the Pacific coast. Houses were excavated and a rich haul of finds resulted. These included objects made from steatite, chipped and ground stone, basketry (both coiled and twined), as well as skeletal remains. There were two main culture levels. It would appear that contacts with folk to the north, settled further down the San Joaquin River, can be predicted, but probably too, especially at the time of the later culture levels, some connexion was established with the folk of the Santa Barbara coast region which, though the other side of the hills, is only some fifty to sixty miles away and reached by several passes. At no time were the Buena Vista people highly civilized, indeed their economy was always elementary. Especially was this true of the earliest occupation where the mano and mealing slab occurred to the exclusion of the pestle and mortar, and the material culture was of the simplest. The dead were buried in the extended position in shallow graves near the camping-grounds. The date of this first occupation is unknown, but at least one of the sites would have been later for a time uninhabitable when, as shown by the deposits, the general level of the lake rose during a period of greater precipitation. The more recent culture shows several distinctive traits and was considerably more developed, perhaps because of its greater contact with the Santa Barbara coastal region. While the results of the investigation do not appear to be startling, they do supply important information about the archæology of a little-known area and fill in one more gap in the regional survey of Southern California.

Horticultural Development of the Cauliflower and Broccoli

An interesting paper by Walter F. Giles (*J. Roy. Hort. Soc.*, 66, Pt. 8, August, 1941) traces the horticultural history of cauliflower and broccoli derivatives from the wild *Brassica oleracea* of our sea-shores. Cauliflowers probably originated in Cyprus, but the time of their appearance does not seem to be known with certainty. The earliest literary reference to a terminal proliferation suggestive of this plant is by Dodoens in 1559. He described the "Flourie Colewort" where "the small stems grow together in the centre, thick set, and fast throng together". Switzer apparently first mentioned broccoli by name in 1728, when he had three kinds growing in his garden at Vauxhall. A great improvement took place in the early years of the nineteenth century, when the modern conception of broccoli as a hardier variant of the cauliflower maturing in winter and spring was established. The origin of broccoli from *B. oleracea* was confirmed by Prof. Buckman, who in 1863 obtained a new hardy sprouting type from the wild plant without hybridization.

Diseases and Pests of Gladioli

The recent widespread increase in cultivation of gladioli has brought a corresponding increase in the number and severity of pests and diseases of this ornamental crop. Lucia McCulloch and C. A. Weigel have recently described these maladies as they affect the plant in North America (Farmers' Bull. No. 1860, Washington, D.C., May, 1941). Some diseases have migrated from other crops, but several parasites, including *Sclerotinia gladioli*, causing dry rot, *Penicillium gladioli* and *Fusarium oxysporum* var. *gladioli*, were associated with this host before the era of its intensive cultivation. The most severe and widespread insect pest is Gladiolus thrips, which appeared in the United States in 1929, and spread rapidly, even threatening the future existence of the crop. Methods of control for this and the other maladies are described in the bulletin.

The Larger Fungi of Trinidad

Three preliminary lists of the fungi of Trinidad appeared between 1911 and 1931, but R. W. Rayner has now published a more detailed account (Memoir No. 6, Imp. Coll. Trop. Agr., Dept. of Mycol. and Bacteriol., Trinidad, April, 1941). The fungi are classified according to a North American system by Murrill. Most of the thirty-five species now listed are somewhat infrequent members of the European flora, but *Pluteus cervinus*, *Psalliota campestris* and *Auricularia Auricularia-Judæ* appear to be as common in this tropical region as they are in Great Britain.

Earthquakes in India

The seismological bulletin of the Government of India Meteorological Department for April, May and June 1940 has just been received. At Agra 82 earthquakes and tremors were registered during the quarter and at the other observatories of Bombay, Calcutta, Colombo (Ceylon), Dehra Dun, Hyderabad and Kodaikanal about the same number were recorded by the seismographs. Some of the earthquakes registered were world-shaking earthquakes from distant epicentres such as the great Peru earthquake of May 24, but a considerable number were shocks in India and the surrounding countries from Persia to southern China. The earthquakes of India and Burma, macroseismic evidence of which has been collected by J. M. Sil at Poona, numbered 7 during the quarter. The first, on April 10, was slight and had an epicentre near 29° N., 81° E. in Nepal; the second, on April 19, was felt at Gauhati, scale 5 (Rossi-Forel); the third, on April 25, was felt at Drosh (scale 6); the fourth, on May 11, had an epicentre near 23° N., 95° E. in Upper Bumar; the fifth, on May 13, was felt at Katamandu in Nepal (scale 5); the sixth, also on May 13, was felt at Dibrugarh (scale 6) and the seventh, on May 27, was felt at Srinagar (scale 6) and Peshawar (scale 4). This last had its epicentre in the Hindu Kush Mountains near latitude 36·5° N., longitude 70·5° E. and its depth of focus was greater than normal, being between 180 and 200 km. deep.

Earthquake Intensities

R. C. Hayes has recently examined the connexion between the intensities of earthquake shocks estimated by means of macroseismic data collected by 132 observers in New Zealand and the same intensities estimated from seismograms ("Measurement of Earthquake Intensity", R. C. Hayes, Bull. S. 61, Dominion Observatory, Wellington, New Zealand,

1941). In New Zealand, Jagger-type strong-motion seismographs were found difficult to standardize effectively and so Wood-Anderson torsion seismometers are being installed. Four of these latter are now in operation in New Zealand, and the logarithmic scale of intensity initiated by Gutenberg and Richter is being used in their interpretation. A plot of instrumental magnitudes so obtained against the surface intensity (Rossi-Forel scale) shows some scatter, which Hayes attributes to variations in depth of focus. In southern California the smallest reported earthquake felt was 1·5 on the logarithmic scale, but on the same scale in New Zealand the smallest felt is seldom less than 3. In New Zealand magnitude $4 \equiv R.F.\ 4$, magnitude $5 \equiv R.F.\ 6$–7 and destructiveness begins about magnitude $6 \equiv R.F.\ 8$.

Molecular Weight of Gliadin

THE molecular weights of gliadin, the protamine of wheat, determined by different methods have been discrepant. The protein is inhomogeneous but the predominant fraction has been separated. Sedimentation gave 27,000, diffusion 27,500, and the shape of the dielectric constant – frequency curve 27,000 for the molecular weight, whereas amino-acid determinations and osmotic pressures gave 42,000 and 40,000–44,000, respectively. P. P. Entrikin (*J. Amer. Chem. Soc.*, 63, 2127; 1941) has redetermined the dielectric constant – dispersion curves with fractionated gliadins. It appears that previous results were not made over a sufficient range of frequencies, and the range 25,000–30,000,000 cycles per sec. was used. The results are accounted for quantitatively by the theoretical equations if the molecules are assumed to be ellipsoidal with a ratio of 8 for the major to minor axes. The molecular weight is 38,000. The results of dielectric constant – frequency, amino-acid, and osmotic pressure methods are thus brought into fairly satisfactory agreement, and gliadin comes into line with zein, the alcohol-soluble protein from maize, for which the molecular weight determinations are 39,000 from composition, 38,000 from osmotic pressure, 40,000 from sedimentation and diffusion, and 38,000 from dielectric constant – dispersion experiments. The high value 8 for the ratio of major to minor axis is similar to that for zein, and these are practically the only molecules belonging to the 40,000 molecular weight class with such high dissymmetry. Dipole moment calculations show that gliadin is much less polar than zein.

Mechanical Behaviour of Bitumen

A TECHNICAL report on the "Mechanical Behaviour of Bitumen", by W. Lethersich, has been issued by the British Electrical and Allied Research Association (Ref. A/T 83. Pp. 28. 15*s*.). Using the classification for bitumens adopted in B.S. No. 688, the author gives the results obtained on six samples of bitumen. He determines also the temperature at which softening occurs, and illustrates apparatus for measuring the extensions of bitumen rods under load and how these extensions are effected by heat. The variation of viscosity with temperature is explained by the fact that the asphaltenes become more widely separated as the temperature increases, thus allowing the dispersion medium to flow more readily between them. The principal conclusions arrived at are that the mechanical properties of bitumen may be represented by an equivalent circuit, either mechanical or electrical, comprising elements containing four physical constants, namely, two viscosities and two elasticities. A knowledge of these constants enables the reaction of a given material to be predicted for various kinds of stress and the regions of plasticity and brittleness to be determined. Bitumen is largely used for the insulation of electrical apparatus and of cable joints and so the problem of 'cracking' due to sudden overloads of current causing mechanical stress is both important and interesting physically. The static value of the bitumens tested over the range of temperature adopted varies little. The dynamic elasticity and the viscosity required to withstand a rapid high stress (impact) or a high alternating stress should be low. Decrease of viscosity with increase of strength (structural viscosity) would appear to be an asset.

Hydrocarbon Flames

SPECTRA of flames of methane, ethylene and acetylene and of compounds found as intermediate products in the chemical studies of their combustion have been examined by W. M. Vaidya (*Proc. Roy. Soc.*, A, 178, 356; 1941). The flames of the Bunsen and Méker burners were also studied. A flame separator was used to get independent observations of the outer and inner cones. The outer cones gave a spectrum identical with that of the CO flame. The inner cones gave in general C_2, CH, HO and the ethylene flame bonds. It is suggested that C_2 may be produced through collisions of CH. Prevalent theories of hydrocarbon combustion are surveyed in the light of the *spectroscopic* observations.

General Classical Theory of Spinning Particles

IN a joint paper H. J. Bhabha and H. C. Corben (*Proc. Roy. Soc.*, A, 178, 273; 1941) give the complete classical theory of a spinning particle moving in a Maxwell field. The particle is assumed to be a point, and its interaction with the field is described by a point charge g_1, and a point dipole g_2. The Maxwell equations are assumed to hold right up to the point representing the particle. Exact equations are then derived for the motion of the particle in a given external field which are strictly consistent with the conservation of energy, momentum and angular momentum, and hence contain the effects of radiation reaction on the motion of the particle. In the paper following (p. 314), H. J. Bhabha gives an exact classical theory of the motion of a point dipole in a meson field, taking account of the effects of the reaction of the emitted meson field. The two papers occupy 78 pages.

Spectrum of the Corona

ACCORDING to Edlén, the prominent green line in the spectrum of the corona is due to Fe thirteen times ionized by some unknown excitation process (*Science News Letter*, 291, May 10). The next three strongest lines, two in the infra-red and one in the ultra-violet, he ascribes to Fe twelve times ionized. Weaker lines are caused by Fe nine and ten times ionized, while eleven and twelve times ionized Ca, and eleven, twelve, fourteen and fifteen times ionized Ni account for others. The ionization energy involved is about 400 v. Boyce points out that Edlén's theory indicates that ultra-violet light of much shorter wave-length than that hitherto considered must fall on the upper part of the earth's atmosphere, a result which will obviously affect the formation of the various ionized layers.

CHEMISTRY IN IRELAND

By Prof. John Read, F.R.S.

An interesting booklet has recently been published which shows us that, despite great handicaps several branches of science were cultivated in Ireland during the seventeenth, eighteenth and nineteenth centuries*. Among them, chemistry was closely linked with medicine, whether studied in institutions or less formally in hedge-schools or as a hereditary interest. Thus, the illustrious Robert Boyle entered chemistry through medicine; and it was during his lifetime that the institutional development of chemistry in Ireland began with the foundation in 1683 of the Dublin Philosophical Society. Richard Kirwan, when he left Ireland for France in the middle of the following century, had received his early education, including a good grounding in chemistry, from a well-known master of a hedge-school at Ballyragget, named Patsull. A century later, Cornelius O'Sullivan—"the founder of the modern science of biochemistry"—won a scholarship from his humble school in Bandon which paved the way for him to study chemistry under A. W. Hofmann in London, and later to specialize in the chemistry of brewing. These are three Irish chemists who rose to eminence at different periods and became fellows of the Royal Society; and there are many others of note in the list of sixty-three names forming the index to the booklet now under notice.

Unlike England and Scotland, Ireland had few links with alchemy or early chemistry. Perhaps the earliest connexion may be discerned in the preparation of a distilled spirit called *usquebaugh* ('water of life'), which gave its name to the later 'whisky' and is said to have been made and appreciated in Ireland so far back as 1100. Even during 1652–53 Robert Boyle found his native land so disturbed that it was "hard to have any Hermetic thoughts in it;" and except for the charlatan, William Butler, the only reputed alchemist in the list we are considering is Peter Woulfe, who invented 'Woulfe's bottle', discovered picric acid, and gained the Copley Medal of the Royal Society in 1768—so that he was not much of an alchemist after all.

Boyle and Woulfe were born in Ireland but prosecuted most of their chemical work elsewhere, and a similar statement applies to many other chemists in the list. Thus, Bryan Higgins, who is said to have almost forestalled the Leblanc soda process, opened a school of practical chemistry in Greek Street, Soho, in which he conducted research work during 1774–96; William James MacNeven, sometimes called the 'father of American chemistry', held the chairs of chemistry and materia medica during 1812–20 in the New York College of Physicians and Surgeons; and James Muspratt, born in Dublin in 1793, became the founder of the alkali industry in England. Muspratt's soda, made at Liverpool by the Leblanc process, was originally given away "so as to prejudice people in its favour", whereupon the demand rose to such heights that new works were erected at St. Helens in 1828. One of his four sons, James Sheridan Muspratt, discovered, in collaboration with Hofmann, *p*-toluidine and *m*-nitraniline, and achieved further fame through his celebrated dictionary of "Chemistry as Applied and Relating to the Arts and Manufactures", published in 1860, to the editing of which Michael Murphy (from Co. Clare) "devoted sixteen hours a day for two years".

Of those chemists who went to Ireland from outside and rendered service to Irish chemistry, Sir Humphry Davy was a veritable bird of passage: in 1810 he gave six popular lectures on electro-chemistry before the Royal Dublin Society for a fee of five hundred guineas, and followed this up in 1811 by six more lectures on agricultural chemistry for which he received seven hundred and fifty pounds. In 1813, Edmund Davy, encouraged perhaps by his cousin's account of Ireland as a sphere of operations for chemists, took up the professorship of chemistry at the Royal Cork Institute, an appointment which he held until 1826, when he succeeded William Higgins in the chair of chemistry of the Royal Dublin Society; it was ten years later that he discovered acetylene.

Chemistry in Ireland in the second half of the nineteenth century owed much to the Royal College of Chemistry, opened in London in 1845 with A. W. Hofmann as the first professor. Of Hofmann's original staff and students, Thomas Rowney, Robert Galloway, John Blyth and Edmund Rolands were all in the course of time appointed to chairs of chemistry in Ireland. In later days such men as Alfred Senier, Sir W. N. Hartley, and Sir G. T. Morgan went to Ireland and made valuable contributions to the development of chemistry in that country.

There is an impressive roll of native Irish chemists who carried out their work mainly in Ireland. Among these may be found, at about the end of the eighteenth century: David MacBride, a contemporary of Joseph Black (himself a son of Belfast parents); Richard Kirwan, author of the well-known "Essay on Phlogiston" (1787); and William Higgins, nephew of Bryan Higgins and occupant of "a place of honour in the development of the atomic theory". Sir Robert Kane, a distinguished figure in Irish scientific and academic circles, is known in chemistry for his preparation of mesitylene from acetone and as the author of a popular text-book entitled "Elements of Chemistry", first published in 1841–43. Maxwell Simpson, professor of chemistry in Queen's College, Cork, during 1872–91, studied under Kolbe and Bunsen, and afterwards worked with Wurtz, in Paris. He "takes his place among the great chemists who laid the foundations of organic chemistry in the nineteenth century". Last in chronological order, but one of the first in chemical genius, comes Hugh Ryan, who worked with Emil Fischer in his classical researches on sugars, and held the chair of chemistry in University College, Dublin, from 1908 until 1931. His death in that year, at the age of fifty-eight, was a severe loss to Irish chemistry, for it is said with truth that Ryan "was undoubtedly the leading organic chemist in Ireland in his day".

* Three Centuries of Irish Chemists. Edited by Deasmumhan Ó Raghallaigh. Pp. 30+4 plates. (Cork University Press, 1941.) 2*s.* 6*d.*

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

MONDAY, NOVEMBER 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Curtin Cosbie: "Brewing, the Story of a National Industry"—2: "The Brewing Process" (Cantor Lectures, II).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—"Spitsbergen in 1941" (Geographical Film).

TUESDAY, NOVEMBER 25

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. J. L. Myres: "Nomadism".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, NOVEMBER 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Howard Robertson: "The Post-War Home, its Interior and Equipment"—1: "The Contributory Industries, What Are They, and how can they help Re-employment?."

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 2.30 p.m.—Dr. A. P. Cawadias: "Hermaphroditism" (Thomas Vicary Lecture).

SATURDAY, NOVEMBER 29

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 11 a.m.—Dr. G. M. Findlay will open a general discussion on "The Mode of Action of Chemotherapeutic Agents".

INSTITUTE OF PHYSICS (MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "Physics in the United States and Recent Practical Applications of Nuclear Physics".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Birkenhead (November 28).

SENIOR PHYSICS MASTER at the Rutherford College Boys' School, Newcastle-upon-Tyne—The Director of Education, City Education Office, Newcastle-upon-Tyne, 2 (November 29).

RESEARCH ASSISTANT IN VETERINARY SCIENCE under the Alan, Duke of Northumberland Memorial Fund—The Hon. Secretary, King's College, Newcastle-upon-Tyne (November 29).

LECTURER IN PHYSICS—The Acting Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (December 3).

SENIOR LECTURER (UNGRADED) IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (December 6).

ASSISTANT POWER STATION ENGINEER for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9746).

LECTURER IN AGRICULTURE—The Registrar, The University, Reading.

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Labour Conditions in West Africa. Report by Major G. St. J. Orde Browne. (Cmd. 6277.) Pp. 149. (London: H.M. Stationery Office.) 2*s*. 6*d*. net. [2710

Medical Research Council War Wounds Committee and Committee of London Sector Pathologists. M.R.C. War Memorandum No. 6: The Prevention of "Hospital Infection" of Wounds. Pp. 30. (London: H.M. Stationery Office.) 6*d*. net. [2910

Proceedings of the Royal Society of Edinburgh. Section B: Biology. Vol. 61, Part 2, No. 11: On the Sphincter Valve of the Antennal Gland of *Marinogammarus marinus* (Leach) sens. tr. By Mary V. Schorstein. Pp. 130–137. 9*d*. Vol. 61, Part 2, No. 13: The Evolution of Continents: a Possible Reconciliation of Conflicting Evidence. By Sir Thomas H. Holland. Pp. 149–166. 1*s*. 6*d*. (Edinburgh and London: Oliver and Boyd.) [311

Other Countries

Smithsonian Institution: United States National Museum. Bulletin 82: A Monograph of the Existing Crinoids. Vol. 1: The Comatulids, Part 4a: Superfamily Mariametrida (except the Family Colobometridae). By Austin Hobart Clark. Pp. vii+603+61 plates. (Washington, D.C.: Government Printing Office.) 1.50 dollars. [2210

South African Institute for Medical Research. Annual Report for the Year ended 31st December 1940. Pp. 67. (Johannesburg: South African Institute for Medical Research.) [2410

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1940. Pp. 8. (Zomba: Government Printer.) 1*s* [2410

Proceedings of the United States National Museum. Vol. 90, No. 3110: A New Harpacticoid Copepod from the Gill Chambers of a Marsh Crab. By Arthur G. Humes. Pp. 379–386. (Washington, D.C.: Government Printing Office.) [2410

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 140: Foot-Rot in Sheep; a Transmissible Disease due to Infection with *Fusiformis nodusus* (n.sp.); Studies on its Cause, Epidemiology and Control. By W. I. B. Beveridge. Pp. 56+8 plates. Pamphlet No. 108: Studies on some Ectoparasites of Sheep and their Control. 1: Observations on the Bionomics of the Sheep Ked (*Melophagus ovinus*), by N. P. H. Graham and K. L. Taylor; 2: Chemical and Biological Studies on Certain Arsenical Dipping Fluids, by M. R. Freney, M. Lipson and N. P. H. Graham; 3: Chemical Observations on Commercial Powder Sheep Dips with Special Reference to their Arsenic Content, by M. Lipson. Pp. 44. (Melbourne: Government Printer.) [2710

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 206: The Vibration and Sound of a Revolving Thin Plate (Acoustical Model of Airscrew Flutter) (Investigations of Airscrew Flutter, Part 3). By Jûichi Obata, Yahei Yosida and Yasuo Makita. Pp. 127–164. 80 sen. No. 207: On the Nature of a Satellite in the X-ray Pattern of α-Crystals, and the Differentiation of a New Phase α′ by the Surface-Recrystallization Method in Certain Ternary Alloys, Part 1: The Iron-Nickel-Aluminium System. By Syûiti Kiuti. Pp. 165–204. 80 sen. No. 208: The Characteristics of the Aerofoil with Discontinuities along the Span, with Special Reference to the Effects of Cut-Out. By Tetusi Okamoto. Pp. 205–264. 1 yen. No. 209: An X-ray Study on the Mechanism of the Splitting Phenomenon of α-Crystals in the Interior of some Ternary Alloys, Part 2: The Iron-Nickel-Aluminium System. By Syûiti Kiuti. Pp. 265–298. 60 sen. No. 210: Resistance Welding of Light Alloys. By the Resistance Welding Research Committee of A.R.I. Pp. 299–482. 3.05 yen. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) [2710

Southern Rhodesia Geological Survey. Short Report No. 35: Geology of the Mafungabusi Gold Belt. By A. M. Macgregor. Pp. 26. (Salisbury: Government Printer.) [2710

Transactions of the San Diego Society of Natural History. Vol. 9, No. 29: The Long-Nosed Snakes of the Genus Rhinocheilus. By Laurence M. Klauber. Pp. 289–332+plates 12–13. Vol. 9, No. 30: A New Species of Rattlesnake from Venezuela. By Laurence M. Klauber. Pp. 333–336. Vol. 9, No. 31: Observations on Plants and Insects in Northwestern Baja California, Mexico, with Descriptions of New Bees. By T. D. A. Cockerell. Pp. 337–352. (San Diego, Calif.: San Diego Society of Natural History.) [2710

Contributions from the Biological Laboratory of the Science Society of China, Zoological Series. Vol. 15, No. 3: The Mammalian End-Brain, 1: The Septum. By Yü-Tao Loo. Pp. 29–70. 2.30 dollars. Vol. 15, No. 4: The Paraphysis in Adult Mammalian Brains. By Yü-Tao Loo. Pp. 71–76. 50 cents. Vol. 15, No. 5: The Paraphysis of *Megalobatrachus japonica*. By Shih-Hsing Yang. Pp. 77–86. 70 cents. Vol. 15, No. 6: The Labroid Fishes of Hainan. By King F. Wang. Pp. 87–120. 1.90 dollars. Vol. 15, No. 7: A Neurological Analysis of the Constitution. By Yü-Tao Loo. Pp. 121–136. 1 dollar. Vol. 15, No. 8: Antioxidants for Edible Fats and Oils. By David H. Jung. Pp. 137–146. 70 cents. Vol. 15, No. 9: Beneficial Influence of Earthworms on some Chemical Properties of the Soil. By Y. Chiung Puh. Pp. 147–156. 70 cents. Vol. 15, No. 10: The Effects of Partial Decortication on Gaseous Metabolism. By Y. J. Wu, T. L. Chiu and C. Ping. Pp. 157–180. (Shanghai: Science Society of China.) [2710

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NATURE

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Nov. 29, 1941

SCIENCE AND ACADEMIC ISOLATION

THE recent Conference on Science and World Order organized by the British Association has undoubtedly done much to clarify among men of science a realization of their social responsibilities. More than this, it has initiated, we hope, a deeper understanding on the part of our leaders and statesmen of the vital position science occupies in a modern community. For science is no mere collection of facts and theories, but a living force for progress. Technological advance would be impossible without the background of a scientific culture. The development of the arts of peace owes much to science. The technique of industrial production is an application of scientific knowledge to human needs ; large-scale agriculture demands the close collaboration of the farmer and the man of science ; public health measures and preventive medicine are often based on the most recent scientific discoveries. It is clear then that increasing the well-being of the ordinary citizen is largely a scientific task. It is equally clear that men of science have not been allowed to direct the application of their results in the social and economic fields to the extent that the importance of their work demands.

In time of war this situation becomes of more serious import, for it is not the development of society which is at stake but its very existence. The exigencies of war raise special problems which can only be solved by the immediate application of scientific knowledge. Yet men of science are employed by Government departments and industrial concerns mainly as advisers with little or no executive authority. Consequently their advice runs the risk of being overlooked or insufficiently implemented. The Civil Servant or factory manager, who in general is not conspicuous for the depth of his scientific knowledge, finds it difficult to understand that an integrated scientific plan is essential for the efficient operation of the war economy. Piecemeal methods often defeat their own ends. The relevant scientific facts must be considered in totality in determining policy. A better state of affairs would result if men of science were given executive authority in those spheres of the national effort in which their work is directly applicable. Mr. Anthony Eden, in his address of welcome to the foreign representatives attending the British Association Conference, suggested that diplomacy in future must be the servant of science, instead of vice versa. It would be an excellent thing if a beginning along these lines could be made now without waiting for the termination of hostilities.

But the onus does not rest solely on statesmen and politicians. It rests very largely on men of science themselves. The undoubted fact that the applications of scientific knowledge for the common welfare have often been frustrated or misused has been regarded with complacency or even cynicism by some men of science. Even to-day there is a too prevalent attitude to let things run their appointed course. There still lingers in the minds of some men of science, including several of considerable achievement, a doubt as to the necessity for the planning of science and organization of men of science for social ends. That this doubt is considerable and honestly held is clear. Planning and organization are held to be detrimental to the absolute freedom of the individual man of science to undertake what research he will when he will.

While the maximum freedom in science is necessary, that such *absolute* freedom of choice is desirable, or even usually obtains, is debatable. It is not sufficiently realized that the type of work that a man of science undertakes in the great majority of instances is conditioned by the fact that he has to earn his living by that work. Except for people with private means and a handful of established university teachers, complete indulgence of the individual's scientific curiosity is impossible. Even in a democratic society, scientific research, taken as a whole, is subject to inevitable restraints and conditions. The problem is not to eliminate them, but to make sure that they are reasonable, socially useful conditions, and that their operation is in the hands of the men of science themselves. This requires democratic organization.

Too often to-day the general guidance of scientific work is in the hands of laymen or persons whose scientific knowledge is incommensurate with the responsibility of their task. We need here to distinguish sharply between conditions of work in university laboratories and research institutions, and those obtaining in industrial and Government laboratories and factories. We need also to appreciate that, particularly in time of war, the overwhelming majority of scientifically trained men and women work under the latter conditions. Sufficient evidence has been accumulated, notably by such bodies as the Association of Scientific Workers, to show that there is room for considerable improvement in many of these places. There can be a great waste of effort among a team of scientific workers if their research is poorly directed and co-ordinated. We are not satisfied that the best use of our scientific brain-power is, in fact, being achieved in this connexion. The frustration the younger scientific worker must inevitably feel when working under inadequate direction was the subject of comment in the leading article of a recent issue of NATURE (November 1). The loss to the nation's effort as a result should also be emphasized.

The long-term view of scientific planning characterized the recent Conference on Science and World Order. It showed that men of science are thinking, in advance, of their part in the planning of the post-war world. Doubts have been expressed as to whether this historic Conference will, in fact, give rise to anything concrete. Surely the correct attitude is to realize that this meeting of men of science was merely an initiation of activity; but, it should be pointed out, of activity on an international scale. Positive results will only be forthcoming in direct ratio to the amount of help given by the individual man of science. The Division for the Social and International Relations of Science of the British Association has set up several committees to deal with some of the problems arising out of the Conference. These committees should not be left to work in isolation but should be given the fullest assistance and encouragement. It is sincerely to be hoped that they will receive the support required to enable them to make contributions of real and lasting value to society.

The British Association, however, is not a formal representative organization of scientific men, and as such its usefulness, although considerable, is limited in certain respects. There are in Great Britain a number of learned and professional societies and associations. In the past these bodies have been mainly concerned with their own particular interests. Yet in so far as they represent men and women with specialized knowledge, they owe it to their members and to the community to participate in the wider affairs of the nation. At the moment their voice is too often silent. The tradition of academic isolation dies hard.

There are several encouraging features in the present situation. The chief of these is the renewed determination to get things done which is exemplified by many of our leading men of science. It is not generally realized how deeply this is reflected among the younger rank-and-file scientific workers. Reference to the desirability of including younger brains on many scientific committees was made in the leading article in NATURE already referred to. But in many cases suitable committees do not exist and need to be formed. We are concerned at the present time primarily with the relation of science to winning the war. Regional production committees need not necessarily seek scientific advice, or accept it after having sought it.

In this respect it should be noted that the Scientific Advisory Committee of the Trades Union Congress seems not to function, although it, or a similar

body, could now express itself directly through T.U.C. members of planning committees. Ways and means should be thought out of bringing scientific advice *directly* to bodies dealing with industrial production. The application of even elementary scientific research to production problems has resulted in the past in an immense saving both of money and labour. There is no reason for supposing that we have reached saturation point in this respect.

The present war situation calls for considerably increased effort by men of science as much as by the factory worker or farm hand. Pre-war concepts of the pursuit of knowledge for its own sake are not now applicable. Every available scientific brain must be at work on problems connected with the War, and co-ordination of effort must be effected. As Mr. J. G. Crowther said at the British Association Conference, a country which has produced Newton, Clerk Maxwell, Faraday, Rutherford and other towering figures does not lack good men of science, and is not to be defeated for want of them. What we must ensure is that the maximum use is made of them in this critical time for ourselves and our Allies. It is timely, therefore, that the Association of Scientific Workers has announced a conference to be held in January on the general topic of science and the War effort (see p. 657). As this body represents in the main young working men of Science and engineers directly engaged with war and production problems, its voice should receive attention. The general body of scientific workers and technicians should use this opportunity of discussing together their important place in the nation's effort. At the meeting of Soviet men of science held in Moscow on October 12 (NATURE, October 25, p. 490) an appeal was broadcast to scientific workers of the world. Their colleagues in Great Britain have the responsibility of answering their appeal concretely and quickly. Messages of support and encouragement serve a limited purpose only. British men of science and engineers must pool all their knowledge, skill and ingenuity to fulfil their part in the pledge which has been given by Lord Beaverbrook: "We've spoken the word, but you must do the deed."

CHRISTIANITY AND THE MECHANISTS

Christianity and the Mechanists
By Dr. W. Osborne Greenwood. Pp. 296. (London: Eyre and Spottiswoode (Publishers), Ltd., 1941.) 9*s*. net.

WHY are writers who approach religious problems from the angle of the sciences so often haphazard in their reasoning, striding forward regardless of obstacles, the moment they quit the strictly scientific beat? They are as reckless as the theologians who dabble in science, and with less excuse; for their scientific training should have taught them to be more careful. The book before us provokes this question. Not that it is lacking in interest or merit, at all events in its negative contentions. The author is a medical man conversant, both within his professional field and outside of it, with the opinions and needs of the public, especially of the younger generation. He knows how their outlook upon the larger problems of life has been prejudiced by uncritical acceptance of the dogmatic tradition of Victorian science, a tradition which still dominates popular thinking, despite the fact that recent developments in physics have gone far to undermine its dogmatism. The majority of the students in our secondary schools and universities still echo the outworn shibboleths and are convinced before their minds are fully fledged that science has scotched religion. It is to such as these, and not to specialist readers, that the author addresses himself.

Dr. Greenwood writes as a believer in Christianity, with engaging sincerity and in a clear and attractive style. He opens with a brief survey (four chapters, comprising the first quarter of the book) of present-day physics, treating with admirable lucidity of the structure of the atom and the problem of entropy, in order to show the grounds that have led many of the leading physicists to postulate a divine mind as the author of the universe. But his main concern is with biology, partly as the field of his own life-work, but chiefly because it is the biologists rather than the physicists who are most solid in their resistance to the hypothesis of theism. He is out to expose the inadequacy of a mechanistic interpretation of the phenomena of life and mind, save in so far as it is regarded as a methodological assumption. "We must be on our guard against overloading a working hypothesis with more than it will or can carry" (p. 146). He shows clearly that a living organism cannot be fully explained by the analytic method which resolves the whole into an aggregate of its parts (p. 129), and that the *form* of organization (this holds also of the physical atom and of the electron) is not a material entity or composed of material entities as its constit-

uents (cf. 44 f., 67). "There is something more in an organism than its several organs and this something is what controls the creature as a whole." How paradoxical is the view which holds the more complex biological structures and activities to be the result of chance is illustrated by a detailed study of *Epeira diademata* (Chapter 10) and of the brain and nervous system (Chapter 11). A like measure is meted out to Loeb's theory of tropisms (Chapter 9).

This argument might have been rendered even more convincing if Dr. Greenwood had instanced the impracticability of giving any mechanistic account of truth. If Loeb's belief in his own theory and its rejection by a disbeliever are equally and alike "conditioned reflexes", what meaning can be attached to the claim that one of the two opposed beliefs is true, and the other false? The beliefs in both cases are determined mechanically by the psychical and physical antecedents, and there is no more to be said.

It is when we pass to Dr. Greenwood's inferences to theism that the question we asked at the outset becomes urgent. He seems to think that the rejection of a mechanistic explanation carries with it of necessity a reference to God as the ultimate ground of Nature. As though these two were the only possible alternatives! He rushes to his conclusions—which, be it observed, may well be true—with a swiftness that makes the reader gasp. Take, for example, the argument on p. 188, based on the unquestioned evidence of religious belief (as of artistic skill) in the cave-dwellers of the third interglaciation period.

"At this juncture it may very usefully be asked of the mechanist, Of what survival value is all this? Any mechanical method of development is at least consistent in one respect, that if any variation appears, be it in organ or habit, function or any characteristic whatever, which is not of some distinct survival value, it is ruthlessly suppressed and cut out. It must be of some definite advantage to the individual or to the race in order to become perpetuated and be a characteristic worth preserving. But a religious spirit and leaning would, among these primitive folk, be precisely one of those possessions which would not help in a material sense to preserve either individual or race. It would not ensure more success in hunting, nor would it, *per se*, help in combat if there *were* such a state of affairs as intertribal war. The religious spirit, therefore, which has not only persisted in spite of these disabilities but grown to the sublime conceptions of to-day, cannot be regarded as due to any mechanical causation but can only be understood when viewed as a divine gift."

An objector will urge, first, that primitive religion has a definite survival value as promoting courage in the individual and social cohesion in the tribe, while the observable decay of religious beliefs in the civilization of to-day is due to the loss of survival value that they once possessed. Further, he will note that Dr. Greenwood is equally ready to credit God with the authorship of much that assists survival and that this, if it be true, seems to show that the presence or absence of survival value is irrelevant to the case for theism. To regard its absence as evidence of divine origin is scarcely complimentary to the Deity. Moreover, even if we allow that mechanical causality fails to explain the phenomena of religion, it by no means follows that they must be interpreted as a divine gift.

There are a host of alternative explanations that call for consideration. A goodly array of philosophers will contend that to seek a ground for the world as a whole is beyond the competence of human reason; that the causal relation holds only within the universe and only of the connexions of events in space and time. It may be questioned, again, whether the universe is a whole and not rather a mass of inter-related phenomena within an ever-expanding context. Even Aquinas held that reason could not disprove the eternity of the material world and that the belief in Creation could be authorized only by revelation. Again (if we are to indulge in this line of speculation), Hume's suggestion that the world is a self-developing organism merits serious discussion, say, in the form given to the theory in Alexander's "Space Time and Deity". Finally, there is the case for regarding the universe as a spiritual whole; in other words, for pantheism. If, as the author contends in agreement with Jeans, the solid matter of the traditional physics has been sublimated into something that looks uncommonly like mentality, why should not the purposiveness discernible in Nature, and the evolutionary process that culminates, for our present knowledge, in mind and personality, be ascribed to the agency of an immanent world-spirit or society of world-spirits? No appeal to Christian theism that ignores these speculative alternatives is likely to evoke a response from the inquiring minds of the present generation.

Our sympathy with Dr. Greenwood's aims makes us all the more sensitive to the shortcomings of his argument. His leading concepts seem to stand sorely in need of clarification. The interesting suggestion (p. 114) that the increase of entropy may be arrested and even reversed by the higher energy of life raises doubts as to the equivocal use of the term 'energy', which are intensified by its extension to spiritual activity as displayed by Christ's *Kenosis* at the Incarnation (p. 65). Later in the book (Chapter 13) we hear of a vitally

important distinction between mind and personality, but are left greatly in the dark when we ask for the precise nature of the difference. It is not enough to be told (p. 213) that personality is conscious individuality; and is the fact that the amœba splits into two instead of dying (pp. 220—221) really pertinent to the Christian hope of immortality? 'Creation' is another ambiguous term of constant recurrence. What does Dr. Greenwood mean when he tells us (p. 197) that "man's mind is of the same nature and essence" as the infinite mind behind the universe, "for it does (within its limited scope) the same creative things"?

God, in creating, creates *ex nihilo*, that is, with no material to work on other than himself. In this lies the radical difference between His creative act and the releasing of pent-up energy from an inert chaos with which it is identified in an earlier passage (p. 47). Perfect inertness and complete absence of organization are not 'nothing' in the absolute sense demanded by orthodox theism. The analogy between divine and human creation has been treated recently, with much more subtlety and caution, by Miss Dorothy Sayers in "The Mind of the Maker".

We offer these criticisms in the hope that Dr. Greenwood may find time, amid his many useful avocations, to develop his constructive argument to theism in more detail. That he has the ability to do this is shown by his convincing refutation of materialism. But there is much in his more positive contentions that needs expansion and clearing up. As it is, he has set himself to prove a little too much and has actually proved much too little.

W. G. de Burgh.

ADJUSTMENT IN MARRIAGE

Happy Marriage

By Norman E. Himes. English edition revised by Lella Secor Florence. Pp. 368. (London: George Allen and Unwin, Ltd., 1941.) 12*s*. 6*d*. net.

Few people would care to deny that marriage relations constitute an important source of the variance of total social happiness. A reasonable interpretation of available evidence makes it likely that marriage originally came into existence as an institution in response to the need for safeguarding the family and its property and hence to acquire rights over the procreative activities of the female. But monogamous marriage in modern society, *de jure* if not entirely *de facto*, still exercises proper functions in regulating the sexual and parental impulses and in providing for various other social and psychological needs. The permanence and stability of marriage are very sensitive to economic and ecological conditions in society. One current difficulty comes to mind. The exigencies of war, compelling prolonged separation and abstinence and, consequently, frustration and conflict, have certainly raised the incidence of psychoneuroses in married women. It is surprising therefore that so little scientific attention has been given to the conditions of a stable and happy union on one hand and of the difficulties that may arise from this union on the other.

The admirable work of Prof. L. M. Terman and his associates at Stanford University is outstanding in this field, and much that is of value in the book under review is a diluted account of Terman's conclusions. Dr. Himes is not concerned in the present study to deal with fundamental problems nor are any new data presented. The reader is offered a handbook of prudent guidance enriched by long experience in the medical problems of contraception. Excursions into economic advice for prospective couples to which a few chapters are devoted may serve a purpose for some of the more suggestible members of the public.

Late age at marriage, by curtailing the child-bearing period, is one factor contributing to a reduced fertility, and it is encouraging to see the strong plea made in this book for earlier marriages both in the interests of fertility and to facilitate sex adjustments in general. The most useful chapters are those that deal with pre-marital and marital sex relations, contraceptive techniques, sterility and venereal disease.

Two points deserve comment. First, the excess of males in the sex ratio is not, as Dr. Himes supposes, due to the higher death-rate of females *in utero* but to the greater number of males conceived; the death-rate of male is higher than that of female embryos. Secondly, to advocate homogeneity of the prospective partners in respect of race, religion, economic and social status, age, education and outlook is dangerous when little or no evidence is adduced in support of the merits of this advice. Such restrictions would strengthen existing class and group stratification and obstruct genetic combinations which are in the interests of the community as a whole.

John Cohen.

ADMINISTRATION AS A SOCIAL PROCESS

Dynamic Administration
The Collected Papers of Mary Parker Follett. Edited by Dr. Henry C. Metcalf and L. Urwick. Pp. 320. (London: Management Publications Trust, Ltd., 1941.)

THE happily chosen title of this collection of papers strikes the keynote which gives them their unity. Behind the admirable analysis of the principles of administration contained in them lies the conception of administration and organization as dynamic rather than static. The task of the administrator is not that of crystallizing the experience of the past in set forms which will guide him in dealing with present or future situations. It is rather that of understanding the whole situation confronting him, recognizing the interacting and unifying elements, and so relating their functions that he sets in motion a process which continuously promotes unity and coherence.

This conception of leadership as the relating of experience and organizing it into power over the situation is elaborated most fully in the two papers on "The Psychology of Control" and on "Leader and Expert", and these with the further paper on "Some Discrepancies in Leadership Theory and Practice" may make the most direct appeal to the scientific worker as such. The same ideas, however, are found in all the papers, the ultimate value of which is indeed in the challenge they offer to constructive and creative thinking at a time when many are being called to fill new administrative posts and when the character of administration over wide fields is subject to searching scrutiny. No reader of those keen examinations of administration and policy provided by the forty or so reports of the Select Committee on National Expenditure can have any doubts as to the great service which Major Urwick and Dr. Metcalf have rendered by editing this collection of lectures at the present time; it is unfortunate that they have not completed their work by providing the book with the index it deserves.

With the exception of the final paper, "Individualism in a Planned Society", which in somewhat different form has been published in the "Papers on the Science of Administration" edited by L. Gulick and L. Urwick, these papers, some of which were delivered in Great Britain but never published, have not been readily accessible, and it is a tribute to the vitality of Mary Follett's thought and the keenness of her analysis that they should make such appropriate reading after the lapse of a decade or more. This is true of international no less than of business situations. Her observation in March 1927 that "we shall never be able to make an international settlement and erect some power to enforce it; the settlement must be such as to provide its own momentum" is a warning for post-war reconstruction that has been forcibly underlined by experience of the last two decades.

A large part of the stimulus of these papers lies in the new points of view they suggest or the new approach to existing problems. They do not provide ready-made solutions to problems that the administrator is likely to encounter, but they do assist him to the fundamental thinking about his problems or situations which will enable him to reach real solutions or control. The emphasis throughout is on the psychological foundations, and the papers on "The Giving of Orders", on "The Meaning of Responsibility in Business Management" and on "Power" are examples of the way in which Mary Follett first demonstrates the shallowness of much conventional thinking, and then enables us to reach the real meaning of situations or problems so essential if the integration on which she insists is to be achieved.

This fundamental thinking is the most valuable feature of these papers, and its applications to the situations that are arising daily in war production or to the problems that will be encountered in reconstruction are almost unlimited. The observations on depersonalizing orders and discovering the law of the situation afford a clue to the solution of many of the acute problems which arise in the control of labour under war-time conditions. These are ideas to be explored further, and they are a typical example of the integration on which Miss Follett insists throughout. They lead naturally to views on conciliation and arbitration and on co-operation advanced in two papers on the psychology of consent and participation and on the psychology of conciliation and arbitration, which some will find novel if not startling.

If these papers can be warmly commended to the practical administrator, they are equally valuable as a contribution to the creative and constructive thought which must precede as well as inspire the making and execution of plans and policy in reconstruction. Miss Follett is more than an expositor of the fundamental principles of organization, so clearly outlined in the final paper

"Individualism in a Planned Society". She sees administration as a social process which, whether in a Government department, an industry or a business, must be integrated with the purposes and welfare of the society of which the more limited activity forms a part. Her view of administration as a continuous and progressing activity is in line with the ideas advanced by Mannheim in "Man and Society in an Age of Reconstruction", and the final two essays provide as complete an answer to those who reject the idea of planning as they do a corrective to the prejudiced or narrow thinking which sometimes characterizes the approach to management problems. Indeed, their contribution to efficient administration is scarcely more direct than it is to the creative thinking by which alone we can evolve the collective controls required to preserve and expand our tradition and heritage of freedom.

R. BRIGHTMAN.

THE LIFE OF INVERTEBRATES

A General Zoology of the Invertebrates
By G. S. Carter. Pp. xxviii+510+13 plates. (London: Sidgwick and Jackson, Ltd., 1940.) 25s.

IN the periodic swing of interest between form and function morphology had a long innings in the schools of Britain, and even now that the animal alive has won its meed of study, the textbooks in general use scarcely reflect the change in outlook that this century has seen. With a telling contribution to the literature of the classroom Dr. Carter has supplied the missing link, and teacher and student will appreciate the labour of collecting and collation which has gathered in a unified survey the results of many scattered investigations.

Two impressions stand out from a reading of his volume: one is of the broad conception of the plan and the thoroughness of its execution, and the other is of the ease and effectiveness of the writing.

The plan is laid around four major topics. The first deals with the properties of protoplasm, the cells and the 'Protista', which are regarded as single cells, for the author rejects the non-cellular conception of the Protozoa since he looks upon a cell as the unit of organization of all animal protoplasm. The second topic, the multicellular body, gives an opportunity for excellent reviews of such subjects as regeneration, dedifferentiation and reconstitution, axial gradients and organizers, and various aspects of the problem of growth. But we miss here any discussion of ecdysis in the Arthropoda or of discontinuous growth in general, or of the recent work upon various types of cuticle.

Comparative physiology is discussed in the longest and most detailed section of the book, marked by a particularly good account of nervous co-ordination. Finally, general problems of invertebrate zoology include life-histories, comparative behaviour, ecology and evolution. Limitation of space has resulted in a somewhat sketchy treatment of the first three, but the last embodies a very interesting speculation upon the evolutionary relationships of invertebrate phyla. The suggestion is that the Metazoa should be divided into two superphyla—the Echinoderm superphylum, including only Echinoderms and Chordates, characterized by pluteus larva, radial cleavage, equipotential development and enterocœl; and the Annelid superphylum including all the remaining Metazoa, except the Cœlenterates and Sponges, with trochosphere larva, spiral cleavage, mosaic development and schizocœl.

The distinctions, however, do not always hold, as the author points out, and in the matter of cœlome development it might be stated that Hamann, Dawydoff, and recently H. Barraclough Fell have shown that even in some echinoderms the cœlom is schizocœlic.

The grouping of the Lamellibranchs as sessile animals is unusual; the figures of the prophase of mitosis scarcely represent the modern view; and in the figures showing parasitic modifications in copepods, that of Achtheres is inaccurate, Penella has an incomplete head, and the series might have been completed by the addition of Xenocœloma, described by Caullery, with its gonads and ducts included in the host and only a pair of egg-sacs outside. The only misprint we have noticed is in the legend of Fig. 51.

These are small matters; the great matter is that here is a work, well indexed, with a useful bibliography mainly of monographs and general reviews, which, as a highly successful and up-to-date synthesis of the biology of invertebrates, meets a long-felt need and will give a new drive to the study of the living animal.

RAMANUJAN

BY PROF. L. J. MORDELL, F.R.S.

PROF. G. H. HARDY who, some thirteen years ago, supervised the editing of Ramanujan's collected papers, has now produced a new volume dealing with Ramanujan.* It is a series of essays rather than a systematic account of his work. However, it includes most of his more important discoveries, and also much recent work associated with the results found by Ramanujan. There are twelve essays, and it will make my subsequent remarks more intelligible if I give their titles in full: (1) The Indian mathematician Ramanujan; (2) Ramanujan and the theory of prime numbers; (3) Round numbers; (4) Some more problems of the analytic theory of numbers; (5) A lattice point problem; (6) Ramanujan's work on partitions; (7) Hypergeometric series; (8) Asymptotic theory of partitions; (9) The representation of numbers as sums of squares; (10) Ramanujan's function $\tau(n)$; (11) Definite integrals; (12) Elliptic and modular functions.

I may as well say at once that the book is beautifully written in an informal style, and reads as smoothly and fascinatingly as a delightful novel. The simplicity and clearness of the style, and the care in setting out the formulæ, are so marked everywhere as to make it plain that the book is certainly a labour of love on which its author has spared no effort. Proofs are given with a minimum of unpleasant detail, with the right emphasis on the salient features and with useful and interesting comments and notes. The book is a model of good exposition. It is a handsome quarto volume printed in such a way as to make it a pleasure to read and a credit to the printers.

The main facts of Ramanujan's career are well known, and the lives of few other mathematicians for some generations past have been so full of human interest. The story of his life is that of the rise of an obscure Indian in the face of the greatest difficulties to the position of the most famous mathematician that India has ever produced and of his early death just after he had won the most coveted distinctions. The publicity given to him suggests that the world likes to hear about mathematicians; and in fact Lord Riddell, the journalist peer, who heard of Ramanujan from Mr. Montagu, at one time Secretary for India, was so interested that he sent for a copy of Ramanujan's collected works and wrote a review, confining himself, of course, to an account of Ramanujan's life.

Ramanujan was born in 1887 near Kumbakonam, a fair-sized town about 160 miles from Madras. Like many other mathematicians, he came of poor and humble folk. His schooling was normal, though at an early age he was recognized as a boy with exceptional abilities. He went to the local high school from the age of seven to sixteen, and in 1904 entered the Government college at Kumbakonam, where he won a scholarship. In no other science as in mathematics is it so easy for a student's interest to be aroused at an early age. The simplest properties of numbers which occur in arithmetic, or the simplest properties of geometrical figures, have often sufficed. Apparently Ramanujan's interest displayed itself when he studied trigonometry and found for himself results given in Part 2 of Loney's "Trigonometry." Then, at the age of sixteen, he borrowed an old book by Carr, "A Synopsis of Elementary Results in Pure and Applied Mathematics". This covers roughly the subjects of Schedule A of the present Mathematical Tripos, and contains the enunciation of some six thousand theorems with proofs that are often little more than cross-references. Carr has sections on algebra, trigonometry, calculus and analytical geometry, and emphasizes in particular the formal side of the integral calculus. It was this book that really awakened Ramanujan's genius. It secured such a grip on him that he is said to have spent all his time at college—including lecture periods in other subjects—upon his mathematics. Many years ago Huxley (and probably many others before him) said that one of the most important objects of any educational system should be to catch the small percentage of the population with some special aptitude, to turn them to account for the good of society, to see that they are not starved by poverty, and that they are put in the positions in which they can do the work for which they are specially fitted. If Ramanujan had lived in Britain he could have started early specialization in preparation for a scholarship examination at one of the universities, with what wonderful results no one can imagine. Unfortunately, the educational system at Kumbakonam was not elastic enough to deal with persons like him. As a result, his neglect of college work other than mathematics led to disaster. He lost his scholarship, left college, ran away from home, came back, returned to college, but did not make up for his absence. He then entered Pachaiyappa's College, Madras, in 1906, but, falling ill, returned to Kumbakonam. He

* Ramanujan: Twelve Lectures on Subjects suggested by his Life and Work. By Prof. G. H. Hardy. Pp. vii+236. (Cambridge: At the University Press, 1940.) 25*s*. net.

appeared as a private student for the F.A. examination in December 1907 and failed. In England he would probably then have been in the middle or near the end of his college career, with possibly the Tripos before him, and also an immediately successful career.

But from 1907 until 1912, Ramanujan was adrift in the world without any definite occupation except his mathematics, which must have absorbed most of his energy. The results of this are embodied in some now famous note-books. In 1909 he married and so, as remarks his biographer, he had to find some regular employment. He had great difficulty in finding any because of his unfortunate college career. In 1910 he began to find more influential friends, who tried in vain to find a tolerable position for him. But in 1912, at about the age of twenty-five, he became a clerk in the office of the Port Trust of Madras at a salary of about £30 per annum. Not much has been published about his life during these critical years 1907–1912. His first substantial paper had been published in 1911 in the *Journal of the Indian Mathematical Society*. In 1912, he began to secure some recognition in India. It is really an easy matter for anyone who has done brilliant mathematical work to bring himself to the attention of the mathematical world, no matter how obscure or unknown he is or how insignificant a position he occupies. All he need do is to send an account of his results to a leading authority. One can recall the classic instances of Jacobi's letters to Legendre announcing his discovery of the elliptic functions, and of Hermite's letters to Jacobi containing his new discoveries in number-theory.

Ramanujan wrote to Hardy in January 1913, sending him the enunciation of a great many results he had found, many of them strikingly original and thoroughly intriguing, others well known, and some false and yet not without considerable interest and significance. Events had begun by this time to take a more favourable turn in India. The University of Madras gave him a scholarship of some £60 per annum, adequate for a married Indian, and he was also sounded about a trip to England, which he declined. In 1914, however, he was prevailed upon to go to Cambridge with help from the University of Madras and from Trinity College. There he had three years of uninterrupted activity and continuous contact with Hardy, the results of which are visible in his "Collected Papers." He fell ill in 1917, and never fully recovered, dying in 1918 shortly after his election to the Royal Society and to a fellowship at Trinity College. He was the first Indian to have been awarded either honour.

It may well be asked at once what kind of mathematics could be done by a person with Ramanujan's training, especially before he came to England, and what characteristics his talents display. Mathematical research is possible in many directions, and two extreme ones suggest themselves. In one, for example, modern algebra, it is necessary to master a technique requiring considerable preparation and study, and research is practically impossible without this. In the other comparatively little pre-knowledge is required; only native wit and exceptional ability and intuition. This applies especially to identities involving infinite series, products, continued fractions and integrals. Probably many of the results found will not be new.

Thus the simply periodic functions, for example, those for which $f(x+1)=f(x)$, and in particular the elementary trigonometric functions, lead to the well-known series and products associated with the sine function, as well as to the familiar Bernoulli numbers in the expansion of $1/(e^x-1)$ in ascending powers of x. Then the hypergeometric series

$$\sum_0^\infty \frac{a.\, a+1.\, \ldots a+n-1.\, b.\, b+1.\, \ldots\, b+n-1}{n!\; c.\, c+1.\, \ldots\, c+n-1} x^n,$$

which includes most of the series occurring in elementary mathematics, lends itself to all sorts of extensions and generalizations. This series is also closely associated with the gamma function $\Gamma(x)$. This function, the characteristic property of which is $\Gamma(x+1) = x\,\Gamma(x)$ and which is a generalization of $x\,!$, is rich in applications to identities of the kind mentioned above.

There are also two classes of far more abstruse functions of the greatest importance in the mathematics of the last century. One is the elliptic or doubly periodic functions, the chief property of which may be typified by

$$f(x+1)=f(x), \qquad f(x+\omega)=f(x),$$

where ω is a complex constant. The simplest elliptic functions are those called $\wp(z)$, sn z, cn z. From the eliptic functions arise the modular functions, of which the simplest have the curious general periodicity property that if ω is a complex variable and α, β, γ, δ are any integers such that $\alpha\delta-\beta\gamma=1$, then

$$f\left(\frac{\alpha\omega+\beta}{\gamma\omega+\delta}\right)=f(\omega).$$

The function which naturally arises in studying such functions can be written as

$$\Delta\,(\omega_1, \omega_2) = (2\pi/\omega_2)^{12} q^2 \prod_1^\infty (1-q^{2n})^{24}.$$

Here ω_1, ω_2 are two complex numbers whose ratio $\omega=\omega_1/\omega_2$ has a positive imaginary part, and $q=e^{\pi i\omega}$ so that $|q|<1$. Then

$$\Delta\,(\omega_1, \omega_2) = \Delta\,(\alpha\omega_1+\beta\omega_2, \gamma\omega+\delta\omega_2).$$

The general theory of elliptic and modular functions has been treated in monumental works by Klein and Fricke, and by Weber, and reveals

at once the most beautiful and fascinating series and products, and enables us not only to prove directly any relevant identities but also to state beforehand their nature and form. Many of these identities can be found by quite elementary means and others by the display of great ingenuity. There may then be no connexion with the general theory, and the results may appear to one unfamiliar with it as an extraordinary collection of strange, curious and isolated results, an impression sometimes heightened by the unusual form in which they can be expressed.

Finally, the theory also shows that if $f(\omega)$ is a modular function and n is any positive integer, then algebraic equations of great interest called modular equations connect $f(n\omega)$ and $f(\omega)$, and that these can be expressed in a multiplicity of ways. Further, if we put $f(n\omega) = f(\omega)$, which then involves $n\omega = (\alpha\omega + \beta)/(\gamma\omega + \delta)$, so that ω is a complex quadratic surd, the equations are solvable by radicals, as was shown by Abel about a century ago. Some of these equations can be solved very simply, while the solution of others involves a wonderful collection of surds.

It was chiefly in these subjects that Ramanujan's best work was done. They gave him ample scope for his exceptional and brilliant genius, which displayed such wonderful imagination, intuition and insight. For formal manipulation of infinite processes and an instinctive feeling for algebraical formulae, he was unrivalled since the time of Euler and Jacobi. His fertility in producing a host of strange and curious results was unbounded and ceased only with his death.

I mention first some results illustrating his inductive powers.

Suppose that q is a complex number and $|q| < 1$. Write

$$1/\prod_1^\infty (1-q^n) = 1 + \sum_1^\infty p(n)q^n.$$

Then the coefficient of q^n in the series is a very important function of n known as the partition function, of which more later. It is easily shown to be the number of solutions in positive integers $x, y, z, t, \ldots$ of

$$x + 2y + 3z + 4t + \ldots = n.$$

Though it had been known and studied since the time of Euler, very little was known of its properties; for example, it is even now not known when $p(n)$ is even or when it is odd. Ramanujan found by observation that $p(5n + 4)$ is divisible by 5, and then proved it. Though no one else had noticed this result, it is easily suggested to anyone studying the numerical values of $p(n)$. A proof is also obvious from the identity

$$p(4)+p(9)q+p(14)q^2+ \ldots = 5\{(1-q^5)(1-q^{10})(1-q^{15})\ldots\}^5\{(1-q)(1-q^2)(1-q^3)\ldots\}^{-6},$$

due to Ramanujan who, however, never published a proof. Many such identities, though striking in appearance, are in fact simply particular results in the theory of the modular functions.

Another result on a rather different footing found inductively without proof by Ramanujan is

$$1+\sum_1^\infty \frac{q^{n^2}}{(1-q)(1-q^2)\ldots(1-q^n)} = \frac{1}{(1-q)(1-q^4)(1-q^6)(1-q^9)\ldots}.$$

What seems remarkable in this formula is that in the product on the right-hand side, the indices of the powers of q are of the form $5n \pm 1$, while in the series on the left-hand side, 5 plays no part in the indices. Such an identity seems very difficult to discover empirically, but still it might be possible for someone without his genius. The formula, which seemed difficult to prove, was in fact originally found and proved by Rogers and then overlooked for some twenty years.

The most remarkable result Ramanujan found inductively, again without proof, is one which would have occurred to very few people indeed. Write

$$q\{(1-q)(1-q^2)(1-q^3)\ldots\}^{24} = \sum_1^\infty \tau(n)q^n,$$

where the product is associated with the important modular function $\Delta(\omega_1, \omega_2)$, so that it can be expected that the coefficients $\tau(n)$ are also important. Then Ramanujan conjectured that

$$\sum_1^\infty \tau(n)n^{-s} = \prod_p (1-\tau(p)p^{-s}+p^{11-2s})^{-1},$$

where the right-hand product is extended over all primes p. This identity implies in particular that $\tau(mn)=\tau(m)\tau(n)$, when m and n are prime to each other. The identity was afterwards proved by Mordell, but only recently Hecke found independently the formula, the proof, and important extensions. Ramanujan also conjectured that if p is a prime number, $\tau(p) \leq 2p^{\frac{11}{2}}$, whence it follows that $\tau(n)$ is of order of magnitude $n^{\frac{11}{2}+\epsilon}$, but no one has ever proved this. Recently Rankine has got so far as $n^{\frac{29}{5}}$.

The most pregnant result stated by Ramanujan is that the coefficient of x^n in $(1-2x+2x^4-\ldots)^{-1}$ is the integer nearest to

$$\frac{1}{4n}\left(\cosh \pi\sqrt{n} - \frac{1}{\pi\sqrt{n}}\sinh \pi\sqrt{n}\right).$$

This statement is false, but the formula is a genuine approximation, though not so close as Ramanujan imagined. This result, included among those sent by Ramanujan to Hardy in 1913, obviously led to the corresponding problem for the function $p(n)$ and to their joint work on partitions. This was the beginning of the method. developed

by Hardy and Littlewood, for solving problems dealing with the partitions of numbers in various ways, and transformed later almost out of recognition by Vinogradoff. Thus Vinogradoff has proved that every sufficiently large odd integer is the sum of three primes. The final result of the original application of the method was to obtain a series giving exceedingly good and rapid approximations to the value of $p(n)$; for example, when $n = 200$, the error made in taking eight terms of the series gives an error of only 0·004 in the value of $p(n)$, a number of thirteen digits. Rademacher has recently replaced the asymptotic series by an equally effective convergent series.

In hypergeometric series, there is an important and fundamental formula involving many parameters due to Dougall; this was rediscovered by Ramanujan, and probably the methods he used would have led to a rigorous proof. From it he deduced a host of other results. He was in possession of yet others, suggesting that he had not revealed all the results in his possession.

Definite integrals greatly interested Ramanujan. Many of his results were found before he came to England and while he held a research scholarship at the University of Madras. It will suffice to mention the following:

$$\int_0^\infty x^{s-1}(f(0)-xf(1)+x^2f(2)-\ldots.)dx = \frac{\pi}{\sin\pi s}f(-s).$$

The result is a purely formal one. It is obviously not true unless the function $f(x)$ satisfies appropriate conditions, since the formula implies the false result that $f(s)$ is identically zero when $f(0)=f(1)=f(2)=\ldots=0$. Often with results found formally without rigorous proof, it is a routine matter to obtain such a proof, but this does not apply to the present one. As shown by Hardy, the proof involves ideas and methods of which Ramanujan knew nothing in 1914 and which he had scarcely absorbed before his death. The formula is a really interesting one suggesting many other results, some of which can be proved in other ways. I wish that Prof. Hardy had given an account of other definite integrals evaluated by Ramanujan, for example, those associated with Gauss's sums. For Ramanujan was the first to evaluate, in a characteristically original way, definite integrals such as $\int_0^\infty \frac{\cos tx}{\cosh x} \cos mx^2\, dx$, which had not been done by writers such as Kronecker and Hardy himself, who had both studied related integrals.

This seems to be the place to speak of Ramanujan's characteristic trait, which made him in his earlier days before his stay at Cambridge almost unique among mathematicians. A mathematical theorem is invariably associated with proof, and no mathematician would be satisfied with a result unless he had a proof. It may happen that he is led to believe in the truth of results which he cannot prove, but this in no way diminishes his desire to find proofs, which are ever his goal. But as Littlewood says: "Ramanujan had no clear cut conception of proof; if a significant piece of reasoning occurred somewhere, and the total mixture of evidence and intuition gave him certainty, he looked no further." This is all the more surprising as the idea of proof is so fundamental even in elementary mathematics. But even in his very first long paper already referred to, which deals with Bernoulli's numbers, after writing down the values of twenty of them, he states that it will be observed, *inter alia*, that the numerator of $B_{2n}/2n$ in its lowest terms is a prime number. He takes the numerical evidence as sufficient, and there is no trace of any suggestion that there is need of other proof of these results, which as it happens, are well known. Proofs of many of the results stated in his notebooks and letters were given afterwards by Hardy and G. N. Watson.

Ramanujan was not a well-read mathematician. In India, he apparently did not avail himself of books that were accessible to him. The only reference I find to books influencing his early work, in addition to those of Loney and Carr already mentioned, is to Edwards's "Differential Calculus" and Hardy's tract on "Orders of Infinity". There were available at Madras several books a study of which might have had a decisive influence on his work, for example, Bromwich's "Infinite Series" and Whittaker's "Modern Analysis", one of which Hardy thinks he may have seen, and also Matthews' "Theory of Numbers". He would have realized that some of the ideas expressed in his early letters were well known; such as the meaning of $\Gamma(n)$ when n is negative, and methods of attaching meanings to non-convergent series. He would have seen how vital it was to replace some of his naive points of view by more rigorous ones; for example, that a distinction must be made between $\sum_1^\infty f(n)$ and $\lim_{s\to 0} \sum_1^\infty f(n)n^{-s}$; and he would not have been so easily led astray by false analogy, as in his work on primes mentioned later. Strangely enough, he must have studied most assiduously some book on elliptic functions, probably Greenhill's. As already remarked, this subject is particularly rich in infinite series and products of a type in which Ramanujan revelled, including applications to modular functions and singular moduli. Greenhill's is an old-fashioned book, and so Ramanujan would be unaware that many of his results, strange and fantastic as they seem to those who have not a modern knowledge of the subject,

are often particular cases of a general theory with which he was unfamiliar. A comparison which suggests itself is that of finding areas and lengths of curves. Before the invention of the calculus, each result proved was no mean feat. After its invention, however, the centre of interest shifted, though one might still admire now and then ingenuity displayed in obtaining special results. Needless to say, Ramanujan showed remarkable ingenuity, and gave proofs of many of his results, but of others he could have had no rigorous proof.

Ramanujan's methods were peculiarly his own. Probably no other mathematician has relied so much upon his native wit. Most mathematicians find it a great advantage to have as extensive a knowledge as possible of lines related to their own. This increases the possibility of successful research, though sometimes there is much to be said in favour of attacking difficult problems unhampered by current ideas as to the method of approach. It is futile to wonder what Ramanujan could have done with the better tools he might have had in more favourable circumstances.

Ramanujan had very little systematic knowledge of number theory. Most of his work on this subject dealt with number-theoretic functions the values or properties of which could be investigated in a non-arithmetical spirit. Prime number theory has so developed during the last fifty years as to suggest that adequate knowledge and training are indispensable for work in this field. Ramanujan had neither, with the result that most of the results to which he was led, some by false and unproved analogies (though even thinking of some of them required a vivid imagination), were either erroneous or erroneously proved, and very little was of permanent value. This applies also to an assertion in one of his first letters to Hardy that "the number of numbers between A and x which are either squares or sums of two squares is

$$K\int_A^x \frac{dt}{\sqrt{\log t}} + \theta(x),$$

where $K=0{\cdot}764\ldots$ and $\theta(x)$ is very small compared with the integral." He later gave a false estimate for $\theta(x)$. The problem was solved by Landau in 1908 and the solution depends upon the application of the standard methods of prime number theory.

Another result mentioned in an early letter to Hardy dealt with a lattice point problem which can be expressed as follows. To find the number of positive integer values of x, y for which $ax + by \leq n$, where a, b are given and n is large. This is an important problem afterwards considered by Hardy, Littlewood and Ostrowski, and it is surprising what interesting developments arose from so innocent looking a problem.

Much more important were Ramanujan's contributions to the question of the representation of numbers as sums of squares; that is, for given k, n to find the number $r_k(n)$ of solutions in integers $x_1, x_2, \ldots x_k$ of $x_1^2+x_2^2 \;\ldots\; +x_k^2=n$. If we write $\theta(q)=\sum_{m=-\infty}^{\infty} q^{x^2}$ the question reduces to that of finding other expressions for $\theta^k(q)$ which allow of simple expansions in powers of q. Thus, as shown by Jacobi,

$$\theta^2(q) = 1+4\left(\frac{q}{1-q}-\frac{q^3}{1-q^3}+\frac{q^5}{1-q^5}-\ldots\right),$$

from which $r_2(n)$ is four times the difference between the number of divisors of n of the respective forms $4m + 1$, $4m + 3$. Expansions had been found by several writers over a period of years in the case of an even number of squares, but there had seemed to be no straightforward method for establishing the formulæ. A general identity was given by Ramanujan for $\theta^{2s}(q)$ without proof but with the characteristic remark "it can be shown". The proper approach to results of this kind is the methods of the theory of modular functions discovered by Mordell, which are also appropriate for the more difficult case when the number of squares is odd, as was discovered later by Hardy.

A fair proportion of the material which Prof. Hardy has now discussed was discovered by Ramanujan in the five years after he left school, and recorded in the notebooks he kept. Some of my previous remarks have shown how unfortunate it was that he had not at an earlier age the advantage of expert guidance and supervision, so that his talents could be properly directed. This would have spared him a great deal of time spent upon known work or upon erroneous ideas, or upon unnecessary elaboration in producing a great many detailed results where perhaps a few would have been sufficient. He would have learnt the importance of rigorous proof. There is of course always the possibility that he might have proved unresponsive to guidance; and after all there is much to be said for experience of any kind that can produce results.

Though Ramanujan had a hard and difficult struggle in his earlier days, it was not so after he wrote to Hardy. In fact, he could not have found a more appreciative, a more generous or a more influential patron, collaborator and friend. Thus it is through Hardy that Ramanujan's name is associated jointly with several beautiful theorems in which he had been anticipated, for example, in the Rogers-Ramanujan identities and in the Dougall-Ramanujan hypergeometric identity. I recall that in the first edition of one of Landau's books, Kakeya's name is attached to a theorem,

but the name completely disappeared in the second edition after Landau had discovered that Kakeya had been anticipated by Eneström. Again, Hardy associates Ramanujan's name in Lecture VIII of the present volume with the asymptotic formula for the number of partitions of n. The proof depends upon Cauchy's integral for a function of a complex variable, a subject of which Ramanujan knew practically nothing. Of course the first suggestions as to the possibility of such results and some indication of their form were due to Ramanujan, and no doubt he was full of suggestions as to the form the final results should take. There would obviously have been no such formula without Ramanujan, and one can easily understand Hardy's gratitude for having come in contact with Ramanujan.

In attempting to assess the standing of Ramanujan as a mathematician, it is difficult not to be influenced by admiration and wonder at his success in becoming a professional mathematician in spite of the greatest difficulties. The estimate depends, as for all mathematicians, essentially upon the novelty and importance of his original work. Though some of it was wrong, and some of no permanent value; though some was over-specialization of results embodied in general theory; though some of his most interesting work was anticipated or not proved, nevertheless, there remains an impressive and formidable balance which has had great influence in shaping the direction of some of the best research since his death. To very few other mathematicians are Klein's remarks made many years ago so appropriate as to Ramanujan. "The secret of gifted productivity will always be that of finding new questions and new points of view, and without these mathematics would stagnate. In a certain sense, mathematics has been advanced most by those who are distinguished more for intuition than for rigorous methods of proof."

THE COSMICAL ABUNDANCE OF THE ELEMENTS*

By Prof. Henry Norris Russell

EIGHTY-EIGHT chemical elements have been isolated. Their separation by chemical means is sometimes easy, sometimes very difficult, and the best available tests differ greatly in sensitivity. Spectroscopic analysis provides a test for all constituents at once; but these tests, too, are unequally sensitive. Fortunately, the two methods supplement one another.

The composition of the earth's crust—above an arbitrary depth, such as ten miles—is well known. Oxygen is the most abundant element, whether by weight or number of atoms. Silicon is next, and then aluminium, iron, magnesium, calcium, sodium and potassium. These eight elements account for 98 per cent of the whole mass—the hydrogen in the oceans for but a quarter of the remainder.

The high mean density of the earth, and the seismological evidence for a liquid core, show that the 'crust' is not a fair sample of the whole. We may hope to do better with meteorites, taking an average of the various types (stone, iron, sulphides) in the ratio of their abundance (10 : 2 : 1, according to Goldschmidt). The result is significantly, but not greatly, different. Iron, magnesium, nickel and sulphur are more abundant; silicon, aluminium, and the alkali metals less. Just these differences are to be expected if the granitic 'crust' of the earth has segregated from a main mass similar in composition to meteorites.

Recent photographic observations of bright meteors show that their orbits were elliptical and of short period, so that they are samples of the solar system rather than the cosmos. Other selection processes may have operated. The spectra of comets suggest strongly that some of the solid bodies whence the gases escape may be composed largely of carbon compounds. Such a body accompanying a stony meteorite in its flight through the earth's atmosphere would be immediately destroyed.

Outside the earth, we must rely on the spectroscope alone. In the stars, the conspicuous differences along the spectral sequence are known to arise from differences of temperature and ionization. Miss Payne's conclusion (1925) that the general run of stars are very similar in composition has been fully confirmed.

Sixty elements have been identified in the sun; and the apparent absence of almost all the rest explained by unfavourable situations of their ultimate lines in the inaccessible ultra-violet. More than forty have been identified in Pegasi.

On good *coudé* spectrograms, equivalent widths of stellar lines may be well measured; and the data for the sun are extensive. To find from these the 'effective numbers of atoms above the photo-

* Abstract of an address delivered at the symposium on September 26, in connexion with the celebration of the fiftieth anniversary of the University of Chicago.

sphere' concerned in producing the line demands a knowledge of the curve of growth. Its theoretical form is well known, but involves the temperature of the atmosphere, the broadening of the stronger lines by collision damping, and the possible effects of turbulence—all involving parameters which must be found from observation.

The 'effective number of atoms' depends on the degree of ionization of the element, the Boltzmann factor for the lower state involved, and the transition probability (or f-value). The first two may be found from the observations if the third is known for enough lines. We have to depend for these at present mainly on an approximate theory. Good observed values are badly needed, and are now being obtained. The position of the 'photosphere' depends on the general opacity and its variation with wave-length (for which our best values still come from the limb-darkening of the sun).

The most comprehensive attempt at quantitative analysis of the sun's atmosphere is still my reconnaissance in 1929, based perforce on Rowland's estimates of intensity, and omitting many refinements for lack (at that time) of data. The calibration thus derived turns out to agree surprisingly well with modern curves of growth.

An analysis by Dr. Leo Goldberg, with all present refinements, is in progress. Through his generosity a comparison with his unpublished results may be presented. They cover at present only the more abundant elements. Omitting elements for which the older determinations were noted as doubtful, the logarithms of the number of atoms above the photosphere differ, on the average, by $\pm$ 0·28, corresponding to a factor of 1·9, while the range in abundance is 200,000-fold. Allowance has here been made for differences in the assumed temperature of the solar atmosphere, and in zero point. Goldberg's absolute values are smaller by a factor of about 30, owing to allowance for collision damping, which was unthought of in 1929.

For these same elements, the relative abundances in the sun, and in meteorites (according to Goldschmidt) show an average discordance of $\pm$ 0·45 in the logarithm, which in view of the uncertainties of determination does not indicate any definite difference in composition. For the rarer elements, the solar values of 1929 are smaller than Goldschmidt's by a factor as great as 20 for the rarest. The abundance of these elements, unlike the others, is found from very faint solar lines. An error in the old calibration of such lines (which was difficult) would account for the discrepancy.

There is therefore no present reason to conclude that meteorites differ in composition from the sun's atmosphere, so far as the metals are concerned.

For the lighter non-metals, the situation is very different. Carbon, nitrogen, oxygen and sulphur have lines in the infra-red, from which the numbers of atoms in the corresponding excited states can be found. But the Boltzmann factors are very large, and the temperature is not known well enough to permit their accurate evaluation. The hydrogen lines are so sensitive to broadening that they cannot be used to obtain its solar abundance.

No fewer than six indirect methods have been developed by various investigators. These give for the ratio of the number of hydrogen atoms to that of all the metals together values ranging from 1,000 to 8,000.

The inert gases show no absorption lines in the sun This serious gap in our knowledge has been filled by an investigation by Unsöld based on measures of line-widths in spectra of the star τ Scorpii, taken at the McDonald Observatory. This gives what appear to be reliable values for the abundance of the light elements, and also of magnesium, aluminium and silicon. For every atom of magnesium or silicon (which are almost equally abundant) there are approximately three of carbon, six of nitrogen, sixteen of oxygen, eighteen of neon, 3,000 of helium, and 16,000 of hydrogen. The enormous preponderance of hydrogen is again confirmed, and helium turns out to be a rather good second. Fluorine, sulphur, phosphorus and argon should be determinable in the same way.

Only the large differences in composition among the stars can be detected, pending study of high-dispersion spectra. The most notable example is furnished by the stars of classes R and N, the spectra of which show enormously strong bands due to carbon molecules and carbon compounds. Here there is no doubt that, as the late R. H. Curtiss first suggested, we have to deal with reducing atmospheres in the ordinary chemical sense, containing more carbon than oxygen, while the great majority of the cooler stars have oxidizing atmospheres, the excess of oxygen permitting the formation of the metallic oxides, which show in their spectra.

At higher temperatures, where compounds are dissociated, differences in composition are spectroscopically less conspicuous. One star of about the sun's temperature, R. Coronæ Borealis, has been found by Berman to contain carbon in great excess, and little hydrogen; and another, υ Sagittarii, analysed by Greenstein, shows helium in great preponderance, and hydrogen almost absent.

In the gaseous nebulæ, and the envelopes of novæ, the density is very low, and the dilution of the exciting radiation great. These conditions strongly favour the emission of forbidden lines, and favour the detection of those elements which have such lines accessible. Nitrogen, oxygen, fluorine,

neon, sulphur, chlorine and carbon have this advantage. Hydrogen and helium, which show strong permitted lines, must be very abundant. The metals are at a great disadvantage, but faint lines of several have been found. Allowing for the very different conditions of excitation, there is small evidence of composition differing from the stars.

The isolated atoms and molecules which absorb interstellar lines are all in the lowest component of their ground-states. Magnesium, silicon, and many other elements are thus removed from observation, and the spectra of the rest reduced to a very few observable lines. Sodium, potassium, calcium, titanium and iron have been detected, and the compounds CH and CN. The electron-abundance, found by comparison of Ca and Ca^+, shows that hydrogen, though not directly observable, is very abundant. In general, there appears to be a great similarity of composition, except for the solid bodies, which are just what might be expected in masses segregated by condensation.

BIOLOGY IN HUMAN RELATIONS*

By Mrs. S. Neville-Rolfe, O.B.E.
British Social Hygiene Council

VICTORY of arms will not remove the causes of war. These lie in the lack of ability, character and emotional development of man himself. If the forces he has created are to be readjusted and canalized to human service and welfare, it is urgent to fit man for the task. The recognition of this possibility and a concentration of effort in an endeavour to understand and improve the quality of man, both of to-day and to-morrow, intellectually, emotionally and physically, would give a re-birth to hope.

The attempt of the Economic Conference to reduce financial tensions by a planned money policy failed owing to the recognition that man has not attained a standard of integrity and trustworthiness requisite to success. Countless instances exist of man's inadequacy being the barrier to progress.

Since the beginning of the century, research workers of the universities, the experimental farms, the consulting rooms and the hospitals have added much factual knowledge to our store, but its application to man has been checked by its seeming conflict with traditional values and by the barriers of prejudice and unreasoning fears inherent in man himself. Biology is being applied to his material advantage in agriculture, in medicine and in food production, but hardly at all to man himself. Psychology has been discovering why man behaves as he does and disclosing the extent to which unrecognized and repressed emotions result in individual and group action entirely contrary to the dictates of intelligence. Physiology is explaining something of the interdependence of mind and body and the results of glandular disharmony on character. Anthropology and sociology demonstrate the dependence of the individual on the group and of the interaction between man and his environment. What we now need is a concerted endeavour to collate, interpret and apply these various discoveries.

Social biology rests on the factual contributions made by all sciences bearing on the development of man. Its task is to correlate and devise methods for their application, related to ethical principles, suited to the general pattern of each social structure.

A wide range of war and post-war problems awaits attention; to select but a few: migration and evacuation in relation to the family; nutrition and maternal mortality; miscegenation; family allowances; optimum marriage age; fertility, care and status of the unfit. The problems are legion. The present urgency is to democratize existing knowledge under responsible auspices.

An ignorant population is in danger—a prey to exploitation in the biological, as well as in the economic and political, fields. The harm can be irreparable when personality itself is injured. We see a terrifying example in the psychological conditioning of Nazi youth to cruelty and the harnessing of its emotional drive to the false values of national aggrandizement. In the biological field the same applies to the ease with which a distorted interpretation of eugenics has been imposed on a biologically ignorant population and used as a political weapon.

Even after two generations of education in Great Britain, the omission of social biology in school curricula has deprived science of an understanding public. Facts are discovered and published, but make little impression on individual practice, social behaviour or administration, as they relate to no emotionally accepted values.

Knowledge of nutrition, heredity and health is

* Substance of a paper read at the Conference on Science and World Order, on September 28.

available, yet bad feeding, unprotected defectives and irresponsible sex behaviour prevail. The evacuation disclosures of habits at direct variance with accepted standards of cleanliness, all demonstrate the futility of a system of education which ignores preparation for life in a living world. Such an omission is a serious handicap to a nation at war.

Measures should be taken forthwith to relate social biology to ethical values, and to apply present knowledge to current problems. This is admittedly incomplete, but each additional fact, each extension of our intellectual range and of our capacity to appreciate beauty in form, sound, colour and sense, each new harmony between intuition and science that illuminates truth, clarifies our spiritual vision. Social biology, drawing its facts from science, may be pictured using them as pieces of a jigsaw puzzle from which each generation must compose the ever-deepening and satisfying key-picture of what man is and can be. We must produce, on the basis of existing knowledge, a rough and tentative outline of that picture, now dimly perceived, of complete and developed man.

Of equal urgency is to promote a wider understanding and development of the whole man. Every educational system has concentrated on the training of intelligence, none has yet taken cognizance of the paramount influence of the emotional condition of man on his behaviour, or attempted to apply even our present knowledge of psychology. We are a world of emotional children with adult minds—babies playing ball with bombs.

A true democracy can only be created by the emotionally and intellectually developed, inspired with a positive purpose in life.

Emotion and intelligence, united in a common objective, obtain astounding results in thought, in action and in conduct, as exemplified by the ideal of the League of Nations, the Battle of Britain, the brotherhood of the bombed and homeless.

Unfortunately, even the groundwork of emotional understanding does not yet form a necessary part of the training of our leaders. Though some training in psychology is given to teachers, little emphasis is placed on the emotional aspect. Normal psychology and emotional development have no definite place in the training of the medical and allied services or in that of the judiciary.

Yet, how can a medical practitioner understand the whole personality of his ordinary patient when the only psychology he has studied is that of the abnormal ? How can the midwife and the health visitor handle problems of family adjustment and emotional stress with no understanding of this side of her own or her patients' nature ? How can the magistrate on the bench judge wisely actions arising from subconscious repressions when these to him appear irresponsible excuses ?

We are adolescents who have grown out of our clothes. The manners and customs fitting the knowledge available in the past constrict development ; the tight buttons of outworn prejudice and the belts and bands of repressed emotion seriously check healthy personal growth and racial progress.

That the younger generation welcomes information and guidance on matters of social biology is evidenced by more than a hundred thousand of the 16–25 age group who have attended *ad hoc* courses of lectures presenting a biological outline of how minds and bodies function, and encourage discussion on the related personal and social questions. These have been provided by progressive local authorities through the British Social Hygiene Council. Since 1934 the Educational Advisory Board of the Council has worked to promote the introduction of biology related to man into the educational system, and has made steady, if slow, progress, now gaining momentum through war conditions.

Up to date, local authorities have sponsored fifteen teachers' courses, and twenty teachers' conferences, and about thirty are now interested in, or considering, emergency programmes. It is a beginning in the effort to equip youth for personal and public life.

It is recognized already in military circles (though not always practised) that those trained and experienced in the War of 1914–18 are not the best improvisors of strategy and tactics for a war of dive-bombers and tanks. This principle applies even more strongly to questions which affect the development of man himself.

The emotionally immature, belonging to a previous generation, with a background of traditional dogma as religion, of *laisser-faire* as social economics, of philanthropic charity as good citizenship, and an idea of the 'equality of man' which ignores biological evidence, are not qualified to govern, or to lead youth in the present world crisis ; yet it is they who are in control to-day. The old in experience and young in mind have ever been outstanding leaders, but the old in mind and years are unable to grasp the new problems or to relate new knowledge to spiritual values. They fear youth and from a mistaken sense of duty they continue to bear burdens beyond their years, and are barring advance. Hence the time-lag between the laboratory and the public is greatest in social biology.

It is vital to reach the younger generation in service and civil life, the parents of the future, and gain their intellectual interest and emotional drive behind the idea that man may control and

direct to the service of man the forces that he has set in motion.

To bring youth into world affairs, they must learn how to participate in the solution of daily problems. In science, in every firm and works, on committees of management, the Whitley Councils, staff and workers' conferences—let the under-twenty-fives be included to an adequate extent in each group represented and secure an equal proportion in each local government committee, social organization and voluntary body. Once the young see some hope of taking an effective share in the national effort, the service will not be lacking. The intelligence quotient reaches its adult level at about thirteen or fourteen. Experience is needed, but so are drive, a new outlook, and faith in man's destiny.

The claim of youth to the knowledge that could equip them for life, the demand for opportunity to enable them to grapple with those problems beyond the grasp of the old in mind, must be met soon, if the younger generation is to contribute effectively to the War and the post-war endeavour.

The present 'youth movement' was inspired from Germany; though misdirected in aim, its methods were effective in giving the Nazi leaders what they sought, because emotional and intellectual efforts were united, leadership was entrusted to youth, and its driving force was positive. The Scout and Guide movement, British in origin, also owed its success to its positive ideal and the leadership of youth. The present youth movement in Britain has not included the biological essentials. The control of the 'movement' is with few exceptions in the hands of older members of education committees, and of voluntary organizations established to meet older ideas and conditions. It is unrelated to reality and therefore unrelated to youth.

The young to-day have a deeper sense of spiritual values, but their positive philosophy must embody all truth as at present perceived. They are politically minded and see in personal freedom and impartial justice man's most precious possession, but of the present incomplete interpretation of the idea of Democracy, of Fascism, Nazism or Bolshevism, indeed of all existing systems, they tend to say "a plague on all your houses; we want something better!" Let them have the opportunity to create it.

PERCH IN BRITISH LAKES

A NEW FISHING INDUSTRY

By Dr. E. B. Worthington

Freshwater Biological Association, Wray Castle

It is common knowledge that progressive changes in the physical conditions of an environment are paralleled by changes in the plant and animal communities inhabiting it. One of the first workers to elaborate the principle for the freshwater environment was Pearsall[1], who illustrated it with reference to the plant communities of the English lakes, but recognized that the animal communities were subject to corresponding changes. Thus, in the fish fauna of the English lakes there is a tendency for the original association of species, dominated by char (*Salvelinus willughbii*) and brown trout, to change into one dominated by perch and pike. Under natural conditions the change is very slow, being connected with the accumulation of silt and the general increase in productivity of water resulting therefrom; but in certain cases unconscious intervention from man appears to have accelerated the process. Thus for Windermere there is some documentary and much hearsay evidence that during the past fifty years the char and trout, which formerly gave rise to prosperous food and sporting fisheries, have been largely superseded by perch and pike, the change having probably been hastened by a general increase of productivity resulting from the addition of sewage.

From the fishery point of view the perch are recognized as a curse not only in Windermere but also in many other lakes in the district (see Watson[2]), because, as their numbers have increased they have become so dwarfed in average size as to be practically valueless to either the angler or the housewife. In order to save the fisheries, it seemed necessary to force evolution backwards, as it were, and thereby to cause the lake's fish biology to revert to the condition it was in, say, a century ago. The War has provided a use for these millions of small, unwanted fish. Their removal will, it is expected, benefit the post-war fishery, and at the same time initiate a large-scale ecological experiment which is likely to repay study for some years to come.

The perch of Windermere was first studied scientifically by Allen[3], who found that for most of its life the perch is a direct competitor with the

trout for food supplies, and showed, with the aid of unbaited traps, that the perch undergoes a definite annual migration, from water deeper than 60 ft. where it spends the winter, into water shallower than 30 ft., to spawn in the spring and afterwards to spend the growing period of summer.

Soon after the outbreak of war in 1939, Allen's results were followed up on a larger scale to ascertain whether a method could be devised for catching perch in numbers large enough for practical fishery purposes, and also to obtain more detailed information about their interesting seasonal migration. Unbaited traps made of wire netting were fished near Wray Castle in depths of water ranging from 5 ft. to 100 ft. continuously for more than twelve months, the traps being lifted three times each week for the removal of fish. A few perch were taken throughout the year, but immediately after the fish had moved into the shallows in the spring they entered the traps in really large numbers for a period of about two months. A catch of five hundred fish from one lift of a single trap was by no means exceptional. The fish taken were all small, averaging a little less than 1 oz. each in weight, and the total weight taken at the optimum depth per trap per night's fishing averaged 8½ lb. over a period of eight weeks.

These perch traps are easy and cheap to make, costing less than £1 each, complete with rope and a marking float. Their manipulation requires but little labour since they remain in the water throughout the fishing season, serving not only to catch the fish but also to store them alive until the appropriate time for landing. Some pike and eels find their way into the traps following the perch, but char are never caught and trout only in the proportion of one to about 50,000 perch, and even these few can be returned to the water undamaged. Therefore, these traps seemed to be ideal instruments with which to make available perch for human consumption, and at the same time to improve the post-war fisheries.

A scheme was drawn up for the Freshwater Biological Association to start a commercial trap fishery on Windermere in the spring of 1941, using 380 traps, the correct depth of fishing to be determined by a pilot series of traps in one part of the lake. Through the good offices of the Development Commissioners and the Ministry of Agriculture and Fisheries, a grant was made to go part way towards the capital cost, and the materials for the traps were made available. Volunteer evening labour was organized among some thirty fishers living near the Lake, so that all the traps could be lifted on two or three evenings each week. British Fish Canners Ltd., of Leeds, conducted trials with samples of the fish and found that by suitable processing they could be canned like pilchards, and this firm offered to purchase the whole catch.

The first season's operations were restricted mainly to the north basin of Windermere and were essentially experimental, but they had the satisfactory result that during two months more than a million perch were sent to the canning factory at Leeds and, packed in about 150,000 tins, are being marketed as 'Perchines (Lakeland Perch)'. In addition, more than 500 eels and about 200 pike were removed from the lake. For the area of water less than 20 m. in depth, which is inhabited by these fish, the cropping rate worked out at about 46 lb. per acre. From the commercial point of view this fishery paid its way handsomely: after deducting running costs such as labour, bonuses to the volunteer fishermen, transport of fish, and allowing a 10 per cent depreciation on the gear, the proceeds from fish sold gave a net return on capital expenditure of 69 per cent during the first season of two months.

Now that the method has been demonstrated, it is hoped that a considerable expansion of this fishery will take place in 1942 and 1943. With this object in view the catching propensities of a few traps were tried out in some eight other lakes in the Lake District during the spring of 1941. In most of these results were promising, and in some the perch traps were found to catch large quantities of eels, which are of considerably higher food and cash value than perch. The method is applicable primarily in those waters where trout fishing is practised, and as such does not in any sense prejudice the angling interests of our freshwaters, but on the other hand offers an opportunity for their improvement. Apart from the Lake District itself, there are many lakes and reservoirs in England, Wales, southern Scotland and Ireland which are suffering likewise from a superabundance of perch. The new method of catching them may have a particular application in storage reservoirs, from which the removal of a crop each year is highly desirable to keep the water in good condition.

Thus it is expected that this new industry has considerable opportunities for expansion during and perhaps after the War, if the necessary organization can be brought into being. In 1942 it is hoped to enlarge considerably the fishery on Windermere and to establish similar fisheries on several other waters in the Lake District. At the same time a few traps will be given a trial in as many other likely waters as possible to prepare the ground for further commercial development in 1943.

[1] Pearsall, W. H., *Proc. Roy. Soc.*, B, **92**, 259–84 (1921).
[2] Watson, J., "The English Lake District Fisheries" (London and Edinburgh, 1925).
[3] Allen, K. R., *J. Animal Ecol.*, **4**, 264–73 (1935).

OBITUARIES

Prof. A. G. Green, F.R.S.

BY the death of Prof. Arthur George Green on September 12, at the age of seventy-seven, the British dyestuffs industry has lost its foremost chemist and an indefatigable champion whose experience had extended over fifty-six years. His genius as a chemist lay in his capacity to produce a simple solution to any problem in hand derived from facts already known, a solution so simple that it had been overlooked by smaller minds enmeshed in the difficulties of a more complex approach.

Green first showed this capacity when, in 1887, at the age of twenty-three, having been appointed to the staff of Brooke, Simpson and Spiller in 1885, he made primuline by the fusion of *p*-toluidine with sulphur, and finding that when sulphonated it possessed affinity for the cotton fibre, he proceeded to diazotize its free amino-group and couple it with various components on the fibre, thus establishing the process of ingrain dyeing which gave to cotton users organic dyes faster in many respects than those they had had heretofore. As an offshoot to this work, in collaboration with Cross and Bevan, he laid the foundation of the modern diazotype copying processes, using diazotized primuline as the light-sensitive medium and developing the screened areas where the diazo-compound had not been destroyed by light, thus producing positives direct. For this he received the Silver Medal of the Royal Society of Arts in 1891.

The dye-making industry was then declining in the face of Continental competition, and a less tenacious man might well have left so unpromising a field from which he had won little but a broad reputation. Green saw, however, that this decline was due to the failure of the empirical methods which had brought Britain success in the Industrial Revolution, and that the cause was to be found in the application by its competitors of a new technique in industry to which the key was the close application of science from day to day, exemplified in the highest degree in the manufacture of the synthetic organic dyes. He refused, therefore, to desert the industry, the salvation of which became a life cause with him, and from 1894 until 1901 he was manager to the Clayton Aniline Company, and after two years as a consultant in London became in 1903 professor of tinctorial chemistry in the University of Leeds.

In his unique combination of theoretical knowledge and practical experience, Green was henceforward recognized as the leading British authority on the dyestuffs industry, and he made every effort to show that its fate in Britain was due to neglect of research. His influence now became profound, for his students included men who were afterwards to carry out the task of rebuilding the British industry, as well as those who were to make their mark among the dye-users. With them he carried out researches on the constitution of aniline black and of the stilbene dyes, together with other work on azo, triphenylmethane, and quinone-imine dyes, much of it inspired by the quinonoid theory of colour.

Green was well known in Germany, where he had a strong friendship with Caro; the spectacle of the creeping madness which has engulfed Germany gave him great pain. On the outbreak of war in 1914, he turned to the question of the supply of explosives, and his method of making picric acid starting from 1 : 2 : 4-chlorodinitrobenzene was widely used. He served on the Ministry of Munitions Committee throughout the War. He resigned his chair at Leeds in 1916 and became director of research to Levinstein Ltd., at Manchester, where in 1917–18 he established the manufacture of mustard gas on the technical scale, a duty the necessity for which he strongly disliked. In 1919 he returned to the dyestuff field and was particularly attracted by the problem of dyeing cellulose acetate silk, for which fibre he produced the first range of special dyes, the ionamines; these are aminoazo bases solubilized as *N*-methyl-ω-sulphonates which are decomposed in the dyebath, regenerating the finely divided base with which the fibre is dyed. Also his work on the sulphuric esters of the β-hydroxyethylarylamines led eventually to the 'solacet' dyes of the Imperial Chemical Industries, Ltd. Unable to agree with the policy of the board, he left the British Dyestuffs Corporation in 1923 and returned to his private practice, which was extensive both in Europe and the United States.

An interest in chemotherapy was early aroused in Green, especially by Ehrlich's view that the action of a drug may be considered as the selective dyeing of the organism invading the body. In partnership with Dr. M. Coplans, he brought out a stabilized form of calcium acetyl salicylate, and in recent years he had been working with the α-sulphonate of *N*-ethylsulphanilamide. He was a member of the Industrial Solvents Committee of the Medical Research Council.

Green was elected to the Royal Society in 1915 and to the livery of the Dyers Company of the City of London in 1918. He was awarded the Dyers Company's Gold Medal for research with two bars, the first and second (with W. Johnson) awards being for his work on aniline black and the third for the ionamines. He was Perkin Medallist in 1917, and in 1934–35 jubilee president of the Society of Dyers and Colourists; as a member of learned societies, he was active in all movements to improve the status of the profession of chemistry.

Green was educated at Lancing and studied under Williamson at University College, London. His shy, sensitive and inquiring nature rebelled at the authoritative tone of the classical-clerical teaching of the 'seventies, which suffered no questioning and no criticism and held the scientific outlook in gentle derision or contempt. Hence his appreciation of much that the humanities stand for was seared; he jettisoned from his mind anything that might bear the taint of mysticism and under a quiet exterior he

applied to life an austere and almost fierce logic which made him a tenacious worker in the laboratory and an uncompromising opponent in the council room. He was a great teacher, visiting his students or staff at the bench. He would carry out a novel synthesis of several stages in test-tubes, and obtain sufficient product both to make a dyeing and a rough assay of its fastness properties; thus he imparted directly his skill, experience and enthusiasm. In return he was given loyalty and affection in an uncommon degree. He disliked all forms of ostentation and few knew how often he gave help to the unfortunate, including the victims of Hitlerite oppression. Finally, in his later years, he had the satisfaction of seeing in the policy of Imperial Chemical Industries, Ltd., towards research the realization of the cause for which he had fought, and nothing gave him greater pleasure than his periodical visits in his advisory capacity to the new laboratories of the Dyestuffs Group at Blackley.

Green's garden was his recreation, but even there he could not resist the urge to experiment, and he had obtained results indicating that traces of fluorescent dyes applied to the soil can affect the growth of plants.

His marriage with Constance Fanny, daughter of Henry Charles Heath, miniature painter, lasted for fifty-two years, and they showed to a wide circle of friends a perfect example of married life. She was a woman of great courage, and had it not been for her influence Green might never have emerged from a life of monastic seclusion to play the part he did. The shock of her unexpected death in January 1941 was one from which an already weakened heart could not recover, and he died suddenly and peacefully in his sleep nine months after her.

K. H. SAUNDERS.

Dr. J. S. Plaskett, C.B.E., F.R.S.

JOHN STANLEY PLASKETT, late director of the Dominion Astrophysical Observatory, Victoria, B.C., who died at Victoria on October 17 at the age of seventy-five, was the doyen of Canadian astronomers. Educated at Woodstock High School in Ontario, and apprenticed to the Edison Electric Company at Schenectady, he gained valuable engineering experience with the Canadian Edison Company at Sherbrook. His chance of securing a university education came somewhat late in life—as he graduated with first-class honours in mathematics and physics at the University of Toronto at the age of thirty-three. It was four years later that his engineering knowledge and experience together with his proved powers of research in photography and spectroscopy led to his appointment to the astronomical branch of the Department of the Interior at Ottawa. In 1905 he led the Canadian Eclipse Expedition to Labrador and was appointed to the post of astronomer at the Government Observatory of Ottawa. Here he was placed in charge of the new 15-in. telescope for which he had already designed the spectroscopic equipment.

Plaskett's early work on stellar radial velocities and on the solar rotation led him to press for a larger telescope to be placed in climatically more suitable surroundings. His efforts were successful and when the Canadian Government established a new observatory at Victoria, B.C., with a 72-in. telescope, on Plaskett fell the main task of dealing with all the optical and engineering problems that had to be faced; to him also naturally fell the task of directing the work of the new observatory. Stellar radial velocities, spectroscopic orbits of eclipsing variables, the physical nature of early-type stars—particularly *O*-type stars—such were the main subjects of his own work and of the researches of his staff. The distribution in space of the interstellar matter which gave the fixed calcium lines in early type spectra was a subject to which he gave much attention. The part of the Milky Way which was accessible to the Victoria Observatory became its special field of work, and Dr. Plaskett was a strong supporter of the scheme to place a companion large telescope at the Radcliffe Observatory, Pretoria, to complete the study of the southern regions of the Milky Way.

Dr. Plaskett was a regular and welcome attendant at the gatherings of the International Astronomical Union, serving on a number of its working committees. After his retirement from Victoria, he was fully occupied with work in connexion with the optical parts of the 80-in. telescope of the Fort Macdonald Observatory in Texas; recent publications have shown with what success he carried out this task. The value of his scientific work was freely recognized. He became F.R.S.C. in 1910, F.R.S. in 1923, and C.B.E. in 1935 on retirement. He was Gold Medallist and George Darwin lecturer of the Royal Astronomical Society, Bruce Medallist of the Astronomical Society of the Pacific, Draper Medallist of the National Academy of Sciences, and was the recipient of honorary degrees at a number of universities. He leaves a widow and two sons, one of whom is Prof. H. H. Plaskett, professor of astronomy in the University of Oxford.

F. J. M. STRATTON.

Dr. Walter Granger

STUDENTS of mammalian palæontology will have learnt with great regret of the death on September 6 of Dr. Walter Granger of the American Museum of Natural History at the age of sixty-eight.

Granger started his career in 1890 in the American Museum as a taxidermist, but an expedition to the Bad Lands of Dakota after living animals, a part of the world famous for its fossils, changed his outlook and started a love of palæontology which determined his future career. How many expeditions he afterwards made to the western States of the United States to search for fossils the writer of this short account, who has a happy personal memory of one of them, cannot record, but the number must have been well over twenty. In addition, Granger worked for a season in the Fayum Desert of Egypt and was second-in-command to Dr. Roy Chapman Andrews, now director of the American Museum, on the important and successful expeditions to Mongolia sponsored by that institution.

As a collector in the field Granger had very few equals. By long experience he seemed to have acquired an extra sense which led him to the places where the best things were to be found and, when discovered, his superb skill in their excavation and preservation, the result of his acquired knowledge and great patience, came into play, as many a specimen in the galleries of the American Museum bears permanent witness.

He was, however, far from being only a skilled collector. His scientific work, chiefly on the mammals of the Eocene Period, if not as great in quantity as that of some of his colleagues, was in no way behind in quality. His papers are models of clarity and conciseness which students would do well to study.

Granger was a most lovable character, entirely loyal to his friends and colleagues and to the American Museum. He was almost unduly modest about his own attainments, but he never withheld sound and generous advice whenever his help was asked. His quiet sense of fun and his good humour and unperturbability over the various worries incident to expeditions will be well known to those that have had the opportunity of being with him in the field.

Born in Vermont, he left for New York at an age too early for a university training, but towards the end of his career Middlebury University of his native State honoured him and itself with a doctorate *honoris causa*.

Granger was one of a band of vertebrate palæontologists who gathered around the late Prof. Henry Fairfield Osborn, and in his career of just over fifty years in the American Museum he performed a life work which is a monument to his memory.

C. FORSTER-COOPER.

Prof. W. H. Heaton

THE death on October 20 of Prof. W. H. Heaton at the age of eighty-five brought to an end a personal association with University College, Nottingham, almost from its beginning.

William Haslam Heaton, born at Bolton in 1856, attended Manchester Grammar School, where he won an open scholarship at Brasenose College, Oxford. He had a distinguished university career and gained the highest distinctions in both mathematics and physics. He was appointed lecturer and senior demonstrator in the Clarendon Laboratory of Physics at Oxford, and was repeatedly appointed examiner to the Universities of Oxford, Durham and Sheffield.

In 1884 he became professor of mathematics and physics at University College, Nottingham, which had been opened only three years before. There were flourishing evening classes, but scarcely any day students. Prof. Heaton's popular evening lectures on scientific subjects were very successful, but a more difficult task was to build up the full-time day work. One step forward was when an Education Department was opened in 1890. In this he played a leading part, as also in setting up a Department of Engineering, which was later followed by a Department of Mining.

Prof. Heaton became vice-principal in 1896, and in 1906 his teaching responsibilities were lightened by the establishment of a separate chair of physics; this gave him more time for consideration of general College policy. In spite of his own tastes lying in the direction of science, he clearly perceived that the development of the College had been one-sided, with the Faculty of Arts lagging far behind. In 1911 he became principal, and at once instituted new professorships of English and mining, to be followed later by several other chairs. Many developments in general policy were made at the same time, and the status of the College soon began to rise. This progress was checked by the outbreak of war in 1914, but a new period of rapid development began in 1919. New laboratories were opened and emergency accommodation of every possible kind was added, but the College grew too large for its existing site. Then came the splendid benefactions of Lord Trent and the opening of new College buildings at University Park in 1928.

Prof. Heaton retired in 1929, but still retained an active interest in College affairs and was repeatedly consulted by his successors in the principalship. His death represents a very great loss to the College he served so well.

H. T. H. PIAGGIO.

Prof. S. Kopeć

NEWS has been received that Prof. Stefan Kopeć, professor of biology in the University of Warsaw, and his son were among those executed near Warsaw as a reprisal for the killing of a Polish 'quisling'. In his early days Kopeć worked on the metabolism of insects with Prof. Garbowski at Cracow. After work on growth in rabbits at the Polish National Institute for Rural Economy at Pulawy he went with a Rockefeller fellowship to the Department of Animal Genetics at the University of Edinburgh. On his return he published a very extensive series of papers on growth and the body proportions of mice. In 1932 he was appointed professor in charge of the Biological Laboratory of the University of Warsaw where he continued his studies on growth. Lately he had been engaged in experimental studies on density of population problems as affecting fertility and growth. His death is a great loss to biological science.

WE regret to announce the following deaths:

Dr. E. S. Beaven, the well-known agricultural botanist and plant breeder, on November 12, aged eighty-four.

Dr. J. A. Hood, founder of the Hood chair of mining in the University of Edinburgh, on November 19, aged eighty-two.

Prof. Walther Nernst, For. Mem. R.S., professor of physical chemistry in the University of Berlin, aged seventy-seven.

Mr. J. F. F. Rowland, formerly public analyst for St. Marylebone, an authority on analytical and bacteriological examination of foodstuffs and water, on November 2, aged seventy.

NEWS AND VIEWS

Veterinary Laboratory, Weybridge

DR. W. HORNER ANDREWS vacated the post of director of the Veterinary Laboratory, Ministry of Agriculture, Weybridge, at the end of September, having held the appointment since 1927. He has taken up an appointment in the office of the Animal Health Branch, Ministry of Agriculture. Prior to taking over the Weybridge post, Dr. Andrews held research appointments in South Africa, where he served on the staff of the late Sir Arnold Theiler. He went to South Africa in 1909 and shared in the research work which led to the development of the Onderstepoort Laboratory near Pretoria which is now so well known. During 1914–18 he joined the South African Army Veterinary Corps and saw service in German South-West Africa, but was recalled to civil duty in 1915. In Africa he had wide experience of virus diseases of animals, Protozoan infections, livestock poisoning and poisonous snakes, and contributed to the literature on these subjects. When a veterinary degree was established in South Africa Dr. Andrews was appointed professor of physiology, and for some years after his return to Great Britain he was an examiner in physiology for the Royal College of Veterinary Surgeons. He was thus able to bring wide experience when he took over the Weybridge Laboratory. In the nature of that appointment much time was devoted to committee work and questions of policy, and much of the development of veterinary research in Great Britain during recent years has been influenced by work done on such committees. Dr. Andrews' personal attention was perhaps directed largely to research on foot-and-mouth disease, consideration of problems relating to bovine contagious abortion, the organization of a growing department dealing with poultry diseases and a host of other questions. The good wishes of his friends go with him in his new field of work.

PROF. T. DALLING is retiring from the chair of animal pathology in the University of Cambridge at the end of this year to assume the directorship of the Ministry of Agriculture's Veterinary Laboratory at Weybridge. He graduated at the Royal (Dick) Veterinary College, Edinburgh, in 1914 and served throughout the War of 1914–18 with the Royal Army Veterinary Corps. Later he joined the late Prof. S. H. Gaiger at Glasgow, and together they worked on some important sheep diseases. Dalling was conspicuously successful in dealing with lamb dysentery, and within a few years, in the course of which he joined the staff of the Wellcome Physiological Research Laboratories at Beckenham, he had discovered the cause and devised a means for its prevention which has resulted in the annual saving of enormous numbers of lambs. This led him and his colleagues to some valuable comparative studies on the transference of maternal immunity to the offspring in different animal species.

At Beckenham Prof. Dalling interested himself with other problems and was one of a team which recognized that a form of infectious jaundice in dogs is caused by the same spirochæte as Weil's disease in man. He was also largely responsible for overcoming the difficulties involved in the preparation and distribution on a large scale of the prophylactics used in the Laidlaw-Dunkin method of immunizing dogs against distemper. He also worked on fowl pox, fowl paralysis, bacillary white diarrhœa and other diseases of poultry. Recently, in collaboration with the late A. Stanley Griffith, he obtained evidence to suggest that the vole type of acid-fast organism discovered by A. Q. Wells may prove of value as an immunizing agent against tuberculosis in cattle.

The Society of Glass Technology

THE twenty-fifth anniversary meeting of the Society of Glass Technology was held at the Department of Glass Technology, Sheffield, on November 19, when in addition to the technical papers which were presented, the day was marked by two interesting official functions. The first was the presentation at lunch of a gold watch and a cheque to Mr. G. S. Duncan, who has recently retired from the post of librarian and assistant to Prof. W. E. S. Turner, after twenty-two years continuous service. These gifts were subscribed by a number of friends in the industry and the presentation was made by Dr. S. B. Bagley, president of the Society. A graceful tribute was paid to Mr. Duncan by Prof. Turner, Head of the Department, who emphasized the almost unique experiences that Mr. Duncan has had, as teacher, soldier and a member of one of the large publishing houses. It is safe to say that no one who has been to the Department of Glass Technology has not received advice and help from Mr. Duncan, and the remarkable development of the Society of Glass Technology is due in no small measure to him.

Later another presentation was made, this time to Prof. Turner himself. Prof. Turner had conferred upon him the honour of fellowship of the Royal Society in 1937 and to mark the occasion a portrait was painted of him in his academic dress by Mr. Edward Halliday, R.A. This portrait was exhibited at the Royal Academy in the summer of 1939 and the portrait was to have been presented to Prof. Turner in October of that year. Owing to the intervention of the War, however, and later to the illness of Prof. Turner, the presentation was not made until recently and it was felt that the twenty-fifth anniversary of the Society was an appropriate occasion. The presentation itself was made by Dr. C. J. Peddle, who was president of the Society in 1939, in a speech which emphasized the importance and unique character of the work that has been carried out in the department by Prof. Turner and his staff. Prof. Turner in replying commented on the

fact that when he first went to the Department of Physical Chemistry at Sheffield in 1904, Dr. Peddle was his first honours student, and later his first research student, and that one of his early students was Dr. S. English, who is president-elect of the Society. Attention was directed to the fact that the painting of the portrait was made possible by gifts from 417 members of the Society, representing eighteen different countries, including some of those with which we are now at war. Coloured photographic replicas of the portrait have been made, and one of these is being kept by Prof. Turner and the other is being sent to the United States, where it will hang in the building of the American Ceramic Society at Columbus, Ohio. Finally, Prof. Turner offered the portrait to the University of Sheffield and this was accepted by Sir Henry Stephenson, pro-chancellor of the University.

Science and the War Effort

THE Association of Scientific Workers is organizing an open conference on the general topic of "Science and the War Effort", to be held in the Caxton Hall, Westminster, during January 10 and 11, 1942. The president of the Association, Mr. R. A. Watson Watt, will open the Conference at 10 a.m. on January 10. The proceedings will then develop in two parallel sessions; one session will be concerned with technical education, which will include the university training of men of science and technicians, also the special technical training of personnel for the Forces and for industry. The parallel session will be discussing building, housing and A.R.P. in the morning; and, during the afternoon, food and agriculture. After tea, both sessions will unite for the main discussion on the latter subject. The session on January 11 will be entirely devoted to discussion of immediate scientific problems in relation to war production and the services. One topic which will be thoroughly examined is the utilization of scientific personnel, about which subject the Industrial Committee of the Association has collected a great deal of material. The remainder of the day will be occupied with the examination of the application of scientific knowledge to production problems and to services problems. This will include consideration of industrial health, conditions of work, and related topics. The final session after tea will be devoted to summing up the results of the Conference.

A feature of the proceedings will be the ample provision for discussion, both during the sessions themselves, and in the tea intervals. It is hoped that members of the general scientific, engineering and technical community will avail themselves of this opportunity. It should be noted that this is the first open conference to be held in Great Britain of scientific workers to discuss their part in the national effort. The Conference Sub-Committee will welcome inquiries and suggestions, both from individuals and from scientific and technical bodies. All communications should be addressed to the Conference Secretary, Association of Scientific Workers, 30 Bedford Row, W.C.1.

American Mathematics and the U.S.S.R.

THE following reply to the message sent by American mathematicians to their colleagues in the U.S.S.R. (see NATURE of November 8, p. 560) was sent from Moscow on October 7:

"Your splendid message, dear colleagues, found wide response in the hearts of the scientists of our country. We read it with feelings of all the more appreciation and satisfaction in that it again emphasized the community of thoughts and the friendly ties between the mathematicians of the U.S.A. and the U.S.S.R. Many years we jointly worked with you on the development of our science, many of our American colleagues were our welcomed guests, while with a still greater number of American scientists we conduct friendly scientific correspondence. This mutual co-operation was very fruitful and led to a number of important scientific discoveries. In recent years our country became the centre of gravity for eminent European mathematicians who were forced to flee the lands downtrodden by the heel of Nazi barbarians. Our country too is subjected to the invasion of these gloomy medieval forces. The Hitlerites seek to smash the U.S.S.R. in order to make their forces afterwards available for destroying also your great country. The fight now being waged by our people is the fight for the progress of all mankind, for everything advanced, the fight for the flourishing of civilization and of science.

"Our science too has been placed at the service of our country for the destruction of Nazism. Soviet mathematicians, like all Soviet scientists, participate in this fight in common with the whole people. This struggle of Soviet scientists is the common cause of the scientists of all democracies, against the fiend who shoots children, burns libraries, smashes universities, and destroys science. On this momentous day your message, dear friends, has been received by us as the proof of the unity of Soviet and American scientists and their determination to fight the twentieth-century vandals till the end. Let the friendship of the Soviet and the American scientists be the surety of the friendship of our great nations, the surety of the victory of democracy over the dark forces of Hitlerism."

The message was signed by sixty-four Russian mathematicians including A. Sobelev, director of the Steklov Mathematical Institute of the Academy of Sciences of the U.S.S.R., and P. Alexandrov, president of the Moscow Mathematical Society.

Colonial Affairs

MR. G. H. HALL, Under-Secretary of State for the Colonies, made a statement on Colonial policy in the House of Commons on November 20. After a striking tribute to the "universal uprush of loyalty to the Throne and support for our cause in all the peoples of the Colonial Empire", Mr. Hall announced that it has been decided to appoint a Colonial Labour Advisory Committee, to function on the lines of the committees already in existence on medical matters and on education. The Committee, which will be a

small one, will consist of representatives of the Colonial Office, and members of the Trades Union Congress and of employers' organizations interested in Colonial affairs. The Colonial Office already has a labour adviser, and the new Committee will serve to strengthen this side of its work. It may be anticipated that as the various provisions of the Welfare and Development Act come more extensively in force, this Committee will grow in importance and its activities play a prominent part in the future of the British Colonial Empire.

A brief survey of Colonial Office activities during the past year was also given by Mr. Hall. Even under war-time conditions it has been possible to send officials of the Colonial Office overseas to examine problems on the spot. Lord Hailey is presiding over a committee examining post-war problems which are likely to arise. Many schemes, amounting to hundreds of thousands of pounds, submitted under the Welfare and Development Act, have been approved. The appointment of an economic and financial adviser to work with Sir Frank Stockdale is being considered. The needs of Colonial peoples in Great Britain have also been examined ; a welfare officer and an assistant welfare officer, the latter an African, have been appointed, and an adviser to Colonial students, who is a West Indian, is being appointed. Mr. Hall concluded by emphasizing that our duty is now to improve the lot of the Colonial peoples, to develop their resources so as to raise their standard of living, and to enable them to take an ever-increasing responsibility in their own government.

Federation of American Societies for Experimental Biology

IN March 1942 the Federation of American Societies for Experimental Biology will issue the first number of a quarterly publication to be named the *Federation Proceedings*. This will be published by an editorial board representing the five constituent societies of the Federation : the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, the American Society for Experimental Pathology, and the American Institute of Nutrition. Four numbers will be published each year. The March issue will appear just previous to the annual meeting of the Federation, and will be composed of two parts. Part 1 will include the abstracts of all the papers to be presented at the annual meeting, about a thousand in all. Part 2 will comprise the programme of the scientific sessions of all the constituent societies of the Federation. The June and September issues will include the full text of perhaps twenty of the papers presented at the annual meeting as selected by the editorial board, including probably the papers on the joint programme of the Federation as a whole as well as the papers of one symposium of each of the five societies. The December issue will include material pertinent to the Federation membership formerly published in the Federation Yearbook, which will hereafter be discontinued. The *Federation Proceedings* will be distributed without further charge to all members of the Federation. The subscription price to non-members will be four dollars (4.50 dollars foreign) payable in advance. Further information can be obtained from Dr. D. R. Hooker, Managing Editor, 19 West Chase Street, Baltimore, Maryland.

Therapeutic Research Corporation

A NEW step in the rationalization of the British fine chemical industry has been taken by the formation of the Therapeutic Research Corporation of Great Britain, Ltd., the directors of which are Lord Trent, of Boots Pure Drug Company, Ltd., Mr. C. A. Hill, of the British Drug Houses, Ltd., Mr. H. Jephcott, of Glaxo Laboratories, Ltd., Mr. T. B. Maxwell, of May and Baker, Ltd., and Mr. T. R. G. Bennett, of the Wellcome Foundation, Ltd. Although each of the directors of the new Corporation is managing director of his own concern, the Corporation is not an amalgamation of these five firms. Each will retain its freedom of action in its special field, but will contribute to the common research pool ; in effect, a much extended research team now becomes available for work on new drugs, and overlapping effort should be eliminated. It is also hoped to secure the interest and co-operation of research workers in academic institutions. The Corporation will have in the various chemical, physiological and bacteriological laboratories at its command the choice of many different lines of approach to its problems and the call on the extensive scientific personnel and equipment of the five companies which are collaborating. This should make for a hopeful start and lay the foundation of a promising superstructure.

Norway: Present and Future

MR. GATHORNE-HARDY's pamphlet "Norway and the War" (Oxford Pamphlets on World Affairs, No. 51. 4*d*. net) gives an account of the physical characteristics and resources of Norway, its people and their democracy, and relations with their Scandinavian neighbours and other powers, which could scarcely be bettered as a contribution to the understanding of the Norwegian resistance to Nazism and of Norway's future. Although little more than a third of the pamphlet deals with Norway and the War proper, the pamphlet contains nothing irrelevant, and it emphasizes the close ties between Norway and Great Britain through the marked similarity of outlook, the ties of the sea, and the long association of various kinds.

Despite the appeal of Germany in scientific and technical circles, Norwegian thought, with its passionate insistence on individual liberty, free speech and parliamentary democracy, is diametrically opposed to the totalitarian ideology, and her neutrality had no spiritual basis. Mr. Gathorne-Hardy emphasizes the important part which confusion, rather than deliberate treachery, played in the situation when Norway was invaded, and also the credit due to the Norwegians for the toughness of their resistance in a singularly desperate situation. After a brief account of the German occupation, he

indicates the re-orientation which is taking place in Norwegian foreign policy, now that isolated neutrality and Scandinavian collaboration have proved insufficient security. As an Atlantic and seafaring nation, Norway seems likely to look for help and collaboration mainly to the free nations overseas—the British Empire and the United States.

Recent Earthquakes

ACCORDING to a message in *The Times*, a violent earthquake was experienced about noon (local time) on November 12 at Erzinjan in Anatolia. A number of buildings were damaged in the town but only a few persons were injured. It is feared that the damage and casualties will be greater in the villages near Erzinjan, and further information is awaited. It will be recalled that a very great earthquake struck the same region on December 27, 1939 (NATURE, January 6, 1940, p. 13).

An earthquake of considerable severity (probably the most severe for eight years) shook Los Angeles on November 14. The electric power station in the Beverly Hills district was temporarily stopped and about a hundred small buildings together with some oil storage tanks were wrecked. Gas and water mains were broken, and some suburban homes in the Torrance Gardena district were damaged. Several parked motor-cars were damaged when the front of a store fell into the street. Damage in one district is estimated at a million dollars. No deaths or serious injuries are reported and further information is awaited. Los Angeles and Hollywood were affected by strong earthquakes on October 11, 1940 (NATURE, November 30, 1940, p. 720), and January 28, 1931, besides numerous other occasions.

Dr. George Birkbeck and Technical Education

ON December 1, a century ago, Dr. George Birkbeck died in London and was buried in Kensal Green Cemetery. His name to-day is recalled by Birkbeck College, London, which began its career as the London Mechanics' Institution with Birkbeck as its president. There were at one time hundreds of such institutions, and no doubt many of them exist to-day, but they may all be said to have sprung from the classes for mechanics started by Birkbeck in 1800 at the Anderson College of Glasgow, in which as a young man of twenty-four he held the chair of natural philosophy. Born in Settle, Yorkshire, on January 10, 1776, Birkbeck studied medicine at Leeds, London and Edinburgh, but he began his active career as a lecturer. In 1804 he set up in practice in the City of London and there became known to Hume, Grote, Brougham, and many other men of liberal ideas. In 1809 he assisted in founding the London Institution, in 1824 became president of the Mechanics' Institution, and was a projector of University College, and a supporter of the Society for the Diffusion of Useful Knowledge. He was, as his biographer J. G. Godard says, a "National Reformer". In the prospectus of his class of 1800, he stated that it was "for persons engaged in the exercise of the mechanical arts, whose education in early life has precluded even the possibility of acquiring the smallest portion of scientific knowledge". He lived to see knowledge brought within the reach of all.

Recent Investigation of New Plant Fibres

AN investigation has been carried out by the Royal Botanic Gardens, Kew, in collaboration with the National Physical and Chemical Laboratories and the Imperial Institute, of the mechanical properties of the fibre from nettle stems (*Urtica dioica*) and other plants native to Great Britain, and of methods of extraction. The nettle fibre has been found to be suitable for the manufacture of high-grade paper, and possibly of textiles, while the leaves are commercially valuable for the extraction of chlorophyll. Arrangements were made for the extensive collection of this abundant raw material during 1941.

The Night Sky in December

THE moon is full on Dec. 3d. 20h. 51m. U.T. and new on Dec. 18d. 10h. 20m. Lunar conjunctions with the planets occur on the following dates: Saturn on Dec. 2d. 9h., Saturn 2° N.; Jupiter on Dec. 4d. 7h., Jupiter 4° N.; Venus on Dec. 21d. 16h., Venus 4° S.; Mars on Dec. 26d. 22h., Mars 4° N.; Saturn on Dec. 29d. 11h., Saturn 2° N.; Jupiter on Dec. 31d. 7h., Jupiter 4° N. Jupiter is in opposition to the sun on Dec. 8, and on Dec. 29 Venus attains its greatest brilliancy; the planet is then 38 million miles from the earth. Mercury is a morning star until Dec. 21, then an evening star. Venus, Mars, Saturn and Uranus are evening stars. Neptune is a morning star and Jupiter is a morning star until Dec. 7, then an evening star. The sun enters the sign Capricornus on Dec. 22, the winter solstice. About this time of the year we have the interesting phenomenon of the mornings decreasing in length while the afternoons and the whole periods from sunrise to sunset are increasing; this, as is well known, is due to the equation of time. The first magnitude star α Tauri (Aldebaran) is occulted on Dec. 30d. 22h. 23·4m., reappearance occurring at 23h. 46·6m. The Geminid meteor shower is active during Dec. 7–15, the radiant being close to α Geminorum. Many interesting objects can be seen during the month, such as the great nebulæ of Orion and Andromeda, the open star clusters of Perseus, the Pleiades and the Hyades, and many well-known double stars and variable stars.

Announcements

PROF. BJORN HELLAND-HANSEN, the well-known hydrographer and head of the Meteorological Institute of Bergen, was arrested some six months ago and is still in prison.

THE title of professor of mining geology in the University of London has been conferred on Dr. W. R. Jones, in respect of the post held by him at the Imperial College of Science and Technology.

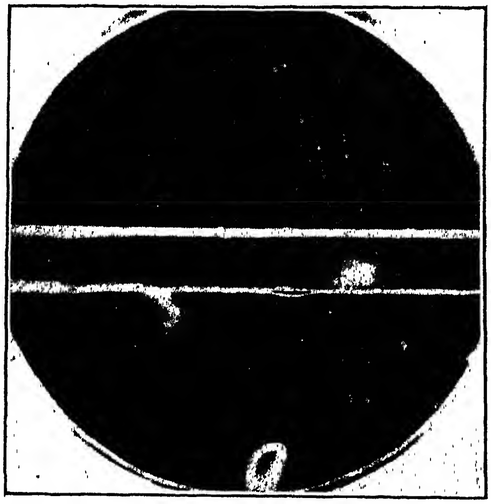
PROF. F. C. BARTLETT, professor of experimental psychology in the University of Cambridge, has been appointed a member of the Medical Research Council in the vacancy caused by the death of Prof. A. J. Clark.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Cloud Chamber Investigation of Penetrating Showers

THE existence of penetrating showers, different from electron cascades or knock-on showers, has been established by counter experiments[1,2]. These experiments are most easily interpreted in terms of showers containing several penetrating particles, though other interpretations cannot be excluded[3].



To investigate the nature of these penetrating showers, we have used a deep cloud chamber controlled by a counter system selective for penetrating showers. The counter system consists of three trays each containing two counter sets. The expansions are controlled by sixfold coincidences, namely, coincidences between six counters, one out of each set. The trays are separated by lead absorbers of sufficient thickness to cut out cascade showers. The total thickness of absorber is 30 cm. The cloud chamber is placed between the top tray and the middle tray. In order to distinguish electrons from penetrating particles, a lead plate 2·3 cm. thick is placed across the middle of the chamber.

The rate of sixfold coincidences is 8 ± 1 counts per 100 hours and is due to the following processes: (1) penetrating showers, (2) triple knock-on showers, (3) casual coincidences. The rate of (2) is estimated as 0·7 counts per 100 hours, while that of (3) as 0·5 counts per 100 hours. Thus most of the observed coincidences should be due to penetrating showers.

One of our photographs, reproduced herewith, shows three penetrating particles traversing the lead plate. The stereoscopic projection shows that the three tracks diverge from a point situated in a lead absorber of 2 cm. thickness which is placed over the top counter tray. A somewhat similar photograph has been reported recently by Powell[4]; pairs of penetrating particles have been reported by various observers[5]. A pair of penetrating particles may consist of a meson and knock-on proton, but this explanation is excluded if there are more than two penetrating particles. Three penetrating particles originating from one point indicates the occurrence of multiple processes.

The accompanying table contains a classification of 32 photographs.

Total number of photographs	Photographs with definitely more than one penetrating particle	probably more than one penetrating particle	one penetrating particle	Big showers	Unclassified photographs
32	2	3	6	4	17

We know from other experiments that the extension of penetrating showers is large compared with the area covered by the cloud chamber and therefore only a fraction of the penetrating particles in any shower is photographed. Further, the density of tracks in the photographs classified as 'big showers' is so great that it is impossible to say whether or not they contain penetrating particles. The photographs obtained may, therefore, be considered compatible with the view that all penetrating showers contain associated penetrating particles. In any case, we can conclude that a not inconsiderable fraction of the penetrating showers contains associated penetrating particles.

It appears from the photographs that the penetrating showers do not consist simply of simultaneous mesons, but are rather complex.

The thirty-two photographs obtained show nine heavily ionizing tracks due to slow mesons or slow protons. Though heavily ionizing particles are known to occur in showers[6], the rate of heavily ionizing particles per photograph in the present investigation is rather high. It seems therefore that the heavily ionizing particles are connected with the penetrating showers.

L. JÁNOSSY.
C. B. MCCUSKER.
G. D. ROCHESTER.

Physical Laboratories,
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Nov. 6.

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[2] Jánossy and Ingleby, NATURE, **145**, 511 (1940).
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Absolute Sensitivity of Geiger Counters

THIS subject has, in recent years, become of interest partly (*a*) in cosmic ray experiments, where information can be gained on the specific ionization of cosmic ray particles (Danforth and Ramsey[1]), or on shower sizes (Ramsey and Danforth[2]), and (*b*) in various applications of the coincidence-counting technique to nuclear physical problems, for example the determination of nuclear level schemes. The latter problem has been admirably discussed by Dunworth[3], following work by Feather and Dunworth[4].

We have carried out some preliminary experiments with single β- and γ-ray counters with the view of determining the absolute yields of some nuclear disintegration processes. Unfortunately, it has become necessary to terminate the work before accurate results could be obtained. The possible errors are indicated below. The greatest experimental difficulty is to bridge the gap between natural ($\sim$2 Mev.) and artificial ($\sim$10 Mev.) γ-ray sources.

In the first place, the counting of cosmic ray particles and γ-rays (2—17 Mev.) involves two different mechanisms, the former utilizing ionization in the gas of the counter and the latter the emission of photo-electrons from the cathode. The counter efficiencies in these two sets of conditions show large differences. For example, Street and Woodward[5] reported efficiencies of about 94 per cent for cosmic-ray particles, using a Geiger counter telescope, and measured the average number of ion pairs/cm. of path produced by the rays. C. G. and D. D. Montgomery[6] quoted data for primary specific ionization in various gases, and the requisite pressures for different efficiencies with a 1 cm. mean free path through the counter; thus air at 2·5 cm. mercury pressure gives 50 per cent and at 16 cm. pressure, 99 per cent efficiency. Again[1], the measured efficiencies were found to agree very closely with those deduced from a knowledge of the primary specific ionization caused by the operative cosmic rays, and assuming that each ion pair caused a counter discharge (100 per cent efficiency).

For the measurement of γ-rays ($\sim$2 Mev. energy) the problem is to calculate the magnitude of secondary electron currents from the counter cathode. The absorption coefficient for 2 Mev. γ-rays (μ/ρ cm.^{2}/gm.) is given[7] as 0·04, variations of μ/ρ with energy being small, so that the above figure approximately holds for the radium family γ-rays. Taking $\mu=0{\cdot}4$ for copper, the percentage loss for 0·8 mm. (the cathode thickness for the tubes used in our experiments) is approximately 7 per cent. If we assume that all the absorbed quanta give rise to 2 Mev. electrons (range in copper$\sim$0·1 cm.) distributed uniformly throughout the absorber, it seems that the counter efficiency should be about 0·7 per cent. It is also assumed that the electronic absorption curve is linear, that all the secondary electrons are projected forwards (that is, the Compton effect $\gg$ the photo-electric effect), so that the second wall of the counter cathode is inoperative, and that any secondaries from the pyrex wall are absorbed by the cathode.

This figure agrees with experimental data. Norling's[8] curve shows (for 2 Mev. γ-rays) an efficiency of about 1·2 per cent for brass, 0·2 cm. thick, data being also given for lead and aluminium. Dunworth's[3] figure, for 0·12 cm. thick brass, is about 0·3 per cent; taken from a very complete curve covering the range 0·2—3 Mev. The shape of such curves was calculated by von Droste[9] and Yukawa and Sakata[10].

Our experiments, in which the expected accuracy was not high, were carried out with single counters located at known (large) distances from calibrated sealed-off radium sources. Care was taken to eliminate scattering so far as possible. It has been stated (Kovarik[11]) that $7{\cdot}3 \times 10^{10}$ and $5{\cdot}6 \times 10^{10}$ quanta/sec./gm. are emitted from radium in equilibrium with its short-lived products with a filter of 0·1 cm. glass and 1·5 cm. lead respectively. In the latter case a brass tube which cut off about 2 per cent of the radiation was also used. The efficiency of a typical counter (4 in. cathode, 1 in. diameter, air at 3·5 cm. pressure) was found to be 0·5 per cent (possible error ± 10 per cent) at 1600 v., with a counter striking potential of about 1450 v. The source used was 0·2 mgm. radium in a monel capsule 0·2 mm. thick at a distance of 80 cm. from the counter. Other counters gave similar efficiencies.

We also determined the efficiency of a β-ray counter (ionization now produced largely in the gas of the tube, not the walls) with a duralumin cathode 6 cm. long 2·54 cm. diameter and $3{\cdot}5 \times 10^{-3}$ inch thick strengthened with circumferential ribs. The counter contained air at 3·5 cm. pressure and was run at 1600 v. (striking potential about 1450 v.). The standard source was 1.21 gm. of powdered uranium nitrate (*A. R.* $UO_2(NO_3)_2.6H_2O$) in a 2 mm. thick brass pot 2 cm. high and 1·7 cm. internal diameter, forming a layer about 3 mm. deep. With the counter 9 cm. from the active layer a count of 512 ± 5 per cent in 20 sec. was obtained. Absorption in the counter walls would be almost complete for the uranium rays, hence the number of disintegrations per gm. uranium per minute is taken[12] as $7{\cdot}2 \times 10^5$. After allowing approximately for the source thickness[13] and the finite dimensions of the counter and source (the errors for this arrangement would be much greater than those for the γ-ray experiment described above), the counter efficiency was found to be 0·27 ± 30 per cent, that is 18–35 per cent. The error could probably be reduced to ± 10 per cent by more accurate calculation. Bramley and Brewer[12] obtained 11 per cent efficiency for one of their counters.

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Nov. 6.

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Interchange of the Ammonium and Potassium Ions in Muscle and Yeast

SINCE the muscle membrane is permeable to the ammonium ion, from the theory of potassium equilibria previously described[1,2], the following should hold:

$$a/a_1 = k/k_1 = h/h_1$$

where a, a_1, k, k_1 and h, h_1 are the concentrations of ammonium, potassium and hydrogen ions outside and inside the membrane. On investigation, it appeared that the ammonium ion (or possibly the minute amount of associated free base) has a marked effect on the membrane itself, all ratios being lowered across it (Fenn and Cobb have described such an effect of ammonia on potassium[3]).

With the sartorius muscle of the frog immersed at 2–3° C. in a Ringer fluid designed to maintain constant volume[2], and in which a has the low value of 1 mgm. NH–N/100 ml., k being 117 mgm./100 ml. (30 m.eq./litre), the equilibrium a/a_1 value of 2·1 is reached quickly, but that for potassium very slowly, since much potassium must come out under these conditions and sodium enter. After forty-eight hours the k/k_1 value approaches that for a/a_1 and has fallen from an initial figure of 4·0–2·3.

When the external potassium is much raised—to upwards of 300 m.eq./100 ml.—with provision for maintaining constant volume[2] the k/k_1 ratio across the membrane is much lowered both theoretically and experimentally, and then small ammonium concentrations have no apparent effect on it. After twenty-four hours in the cold, with external k of 150, 210 and 300 m.eq./litre, the a/a_1 values are 1·51, 1·33, and 1·28, the k/k_1 equilibria even without any ammonium being 1·56, 1·36 and 1·28. The results are therefore in accord with theoretical expectation and show a specific effect of the ammonium salt on the muscle membrane.

Yeast. The specific membrane effect of the ammonium ion (or associated base) on muscle is not evident with yeast, and ammonium ion can be made to replace the *whole* of the potassium within the cell, after which it can be taken out and the potassium replaced. (At the same time it may be noted that the simple equilibrium equations applicable to a distensile membrane are not valid for the comparatively rigid membrane of yeast.) A striking peculiarity of the yeast permeability is that the replacement with ammonium goes at a practically negligible rate unless the yeast mixture *is bubbled with carbon dioxide* (3–10 per cent), bubbling with oxygen at the same pH being almost ineffective. Even with carbon dioxide the entrance is very slow compared with muscle and considering the size of the yeast cell. After forty-eight hours at room temperature all the potassium can be taken out, though much the greater part is lost in twenty-four hours and occasionally practically all of it. The following example may be given:

Sample of pressed bakers' yeast suspended in Ringer solution for a short time and centrifuged.

K content	450 mgm./100 gm.
NH–N ,, ...	< 1 mgm./100 gm.

Bubbled for 24 hr. with 3 per cent CO_2, 97 per cent O_2, in Ringer fluid containing 11·9 m.eq. bicarbonate/litre and varying strengths of NH_4Cl.

NH_4Cl in Ringer fluid →	$N/5$	$N/20$	$N/100$
NH_3–N in yeast	400	174	51
K—in yeast (mgm./100 gm.)	0	192	268

Yeast centrifuged and washed in a similar Ringer fluid containing 30 m.eq./KCl per litre and no NH_4Cl; then bubbled in this fluid as before for 24 hr.

NH_3–N in yeast	47	17	7
K—in yeast (mgm./100 gm.)	425	455	436

The complete replacement of the potassium with NH_4 followed by the subsequent reversal shows that potassium in yeast is altogether in the ionized condition.

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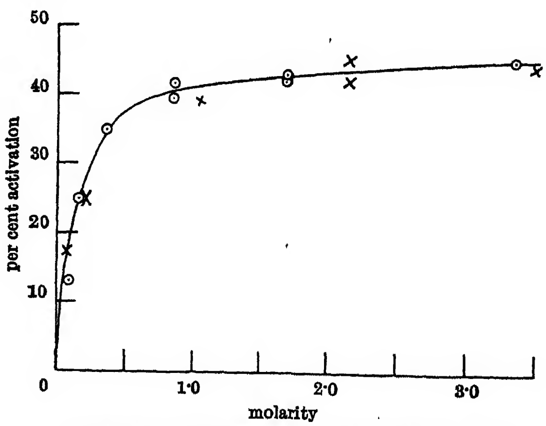
Sept. 16.

[1] Conway, E. J., and Boyle, P. J., NATURE, 144, 709 (1939).
[2] Boyle, P. J., and Conway, E. J., *J. Physiol.*, 100, 1 (1941).
[3] Fenn, W. O., and Cobb, D. M., *J. Gen. Physiol.*, 17, 629 (1934).

Effect of Sodium and Potassium Ions on Cholinesterase

Mendel, Mundell, and Strelitz[1] reported inhibition by potassium ions, and activation by calcium ions, of cholinesterase from horse serum; and they suggested that certain physiologically antagonistic actions of these ions might be explained on this basis. Nachmansohn[2] stated that sodium and potassium ions in high concentrations activate the cholinesterase from the electric organ of the Torpedo to the same degree, but no experimental data were given. Nachmansohn's communication evoked critical replies from Mendel, Mundell, and Strelitz[3], and Massart and Dufait[4]. The former authors raised the possibility of differences in the enzyme systems in horse serum and Torpedo, and also suggested that the sodium and potassium salts used by Nachmansohn may have contained sufficient of the activating bivalent metals to give the effect he reported.

In order to throw light on this controversial issue the present study was made, dealing with the effect of the addition of chemically pure sodium chloride and potassium chloride to cholinesterase-acetylcholine chloride systems using dialysed horse and rabbit sera as sources of the enzyme. The usual manometric method employing the Warburg apparatus was used with the substitution of 0·20 per cent $NaHCO_3$ for bicarbonate-Ringer solution. The accompanying figure demonstrates the activating effect of both salts upon the activity of the rabbit enzyme. However, neither of the salts produced a consistent activation



EFFECT OF SODIUM AND POTASSIUM IONS ON CHOLINESTERASE IN RABBIT SERUM.

×, NaCl; ⊙, KCl. Hydrolysis measured at 30° C. in a total volume of 4 c.c. containing 15 mgm. acetylcholine chloride and 0·2 c.c. dialysed serum. Reaction period, 120 minutes. Corrections applied for non-enzymatic hydrolysis in presence of the corresponding concentration of the appropriate salt.

or inhibition of the horse serum enzyme. In some experiments small activations or inhibitions were observed, but these were not reproducible, and hence must be considered the result of experimental variation.

The points of accord and conflict between the present findings and previously published work are apparent. In agreement with the suggestion of Mendel, Mundell, and Strelitz[3], it would appear that the source of the enzyme is a crucial factor in determining the effect of sodium and potassium ions on cholinesterase. Nachmansohn's statement[2] that ". . . the enzyme is only active in the presence of divalent cations. After dialysis the enzyme practically completely loses its activity" may apply for cholinesterase from the electric organ of the Torpedo, but does not for the enzyme from horse or rabbit serum.

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Oct. 23.

[1] Mendel, B., Mundell, D., and Strelitz, F., NATURE, **144**, 479 (1939).
[2] Nachmansohn, D., NATURE, **145**, 513 (1940).
[3] Mendel, B., Mundell, D., and Strelitz, F., NATURE, **145**, 822 (1940).
[4] Massart, L., and Dufait, R., NATURE, **145**, 822 (1940).

Science in the U.S.S.R.

THE words quoted by Prof. J. B. S. Haldane[1] occur in a letter written by Boyle at the age of nineteen years and nine months. One can well imagine how their author in his maturity might have deprecated what has been read into them, in some such way as "I scruple not to say, that those who know me best, will scarce believe me apt to constrain Natural Philosophy into a course so strait, as some wou'd pretend".

Prof. Haldane also makes the remarkable assertion that Thomas Sprat, the literary divine who was the early historian of the Royal Society, postulated "a class basis for science". That is exactly what Sprat did not do; nor, so far as I know, did any of the creators of the Society, for they came of all classes and they held it open to all who were able. Thus, another letter from the youthful Boyle, written five months after that which Prof. Haldane has used, remarks of the leaders of the Invisible or Philosophical College that, "though ambitious to lead the way to any generous design, [they are] of so humble and teachable a genius, as they disdain not to be directed to the meanest, so he can but plead reason for his opinion; . . .". And there should be set against Prof. Haldane's sentence taken from Sprat's "History of the Royal Society" a number of passages from the same work, which show the "comprehensive Temper" of British science as it then was; I choose one only (1667 ed., p. 67):

"But, though the *Society* entertains very many men of *particular Professions*; yet the farr greater Number are *Gentlemen*, free, and unconfin'd. By the help of this, there was hopefull Provision made against *two corruptions* of Learning, which have been long complain'd of, but never remov'd: The *one*, that *Knowledge* still degenerates, to consult *present profit* too soon; the *other*, that *Philosophers* have bin always *Masters*, & *Scholars*; some imposing, & all the other submitting; and not as equal observers without dependence.

"The first of these may be call'd, the *marrying of Arts too soon*; and putting them to generation, before they come to be of Age; and has been the cause of much inconvenience. It weakens their strength; It makes an unhappy disproportion in their increase; while not the *best*, but the *most gainfull* of them florish: But above all, it diminishes that very profit for which men strive. It busies them about possessing some petty prize; while Nature itself, with all its mighty Treasures, slips from them; . . ."

So far as a movement must be judged at all by isolated quotations instead of by the sum of acts and deeds, these two passages convey, I believe, a much less misleading idea of historical fact than do those which Prof. Haldane has chosen.

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Nov. 15.

[1] NATURE, **148**, 598 (Nov. 15, 1941).

WHAT Mr. Maisky said exactly and what was the context make such a difference that I do not propose to argue or comment on his words. Short quotations without the full story are very dangerous and unfair, as I know to my cost.

It is with Prof. Haldane's conclusions as to British science that I wish to deal. The words of Boyle and Sprat may indeed have been inspired by the desire at that time to get going an organization of real science, as compared with alchemy, and the difficult task with this was, I have no doubt, the fact that it had to be wrapped up with the possibility of utility.

To say, as does Prof. Haldane, that British science is applied and not pure seems to me a travesty of fact. If it were so, some of the great work of the past must have been related to objectives rather than to knowledge for knowledge's sake. It would follow that Darwin did his work in order to organize a menagerie; that Crookes's work on the exhausted tube was based on a keen desire to develop neon advertisements; that Thomson juggled with electrons in order to sell radio sets; and I suppose Eddington's theory of the expanding universe might at a future date be related to a keen desire to increase the value of real estate.

If there is a criticism to be made of British science, then I think it is that the team of applied scientists do not rally enough round the pure scientists. The standard example of this is the discovery of the great dyes, which were turned into an industry in Germany by the applied scientists in that country.

I have at the present time the honour of being associated with many physicists working on *ad hoc* problems connected with the War. It is indeed remarkable what they do, and they deserve the nation's profound thanks. I do notice, however, a keen desire on their part to get away from the particular to the general. I like this tendency. It is healthy and praiseworthy, but according to Prof. Haldane against the traditions of British science. I cannot accept this.

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RESEARCH ITEMS

Electrical Phenomena in Heart Muscle During Activity

J. A. E. EYSTER, in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15, dealt with the electrical potentials which develop in the heart in the interval immediately preceding and during the contraction of the organ, and their relation to the contraction process. Potential-time curves of two types, unipolar and differential, are recorded by means of direct current amplifiers and cathode ray oscillographs, along with a constant reference curve. The characteristics of these curves and their relation to each other and to the onset of contraction in the various localized regions of the heart will be discussed. The electrical phenomena are characterized by their polar distribution. Regions of positive and negative potentials arise simultaneously, undergo growth and decline, and a certain shift in their spatial relations during the action potential period. It is shown that the onset of contraction in any region is coincident with the maximum flow of electrical current in the region, established by neighbouring regions in which the potentials are respectively above and below the potential of resting muscle.

Defective Fat Metabolism and Arteriosclerosis

THIS was discussed by L. R. Drogstedt in a paper read at the Autumn Meeting of the U.S. National Academy of Science held during October 13–15. Arteriosclerosis is not a necessary part of the ageing process, since not all old people develop it. The following evidence suggests that it may represent a metabolic defect associated with disturbed fat metabolism. The feeding of cholesterol in excessive amounts produces arteriosclerosis in rabbits that resembles very closely the human disease. The incidence of arteriosclerosis is abnormally high in patients with diabetes mellitus and occurs not infrequently in young individuals. Diets rich in fat are especially apt to produce arteriosclerosis in diabetics, and conversely, low fat diets have a protective effect. A similar high incidence of arteriosclerosis is found in depancreatized dogs in which a disturbance in fat utilization is produced by deprivation of lipocaic.

Origin of the Temperate Floras of South America

THIS was discussed by D. H. Campbell in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences during October 13–15. The continents of North America and Eurasia have very similar temperate floras and have always been more or less closely united. The climate is a continental one with great extremes of temperature. There is in the northern regions a preponderance of conifers and deciduous angiosperms. In South America, the temperate regions are very limited in extent, and the climate is much more temperate, with no such marked differences between winter and summer. The vegetation has little in common with the north temperate floras, but in the extreme south has many types common to New Zealand and Australia, and to a less degree to South Africa. As shown by fossils from the tertiary of Argentina, there is a large element derived from the tropical regions of Brazil, while at the south the 'sub-antarctic' flora predominates. It is evident that the modern floras differ but little from the tertiary ones. It seems likely that the northern and southern temperate floras have always been separate, and they have probably been distinct since the late Palæozoic.

Foot-Rot in Sheep

THE spreading destruction of superficial parts of the underlying epithelium of the sheep's foot, leading to detachment of the horn, is a disease hitherto very prevalent in the moderate rainfall areas of southern Australia. The primary causal agent has now been shown by Beveridge (Bull. 140, Australian Council for Scientific and Industrial Research, 1941) to be a newly discovered bacterium for which the name *Fusiformis nodosus* (n. sp.) is suggested. It is a large, anaerobic, Gram-negative, non-mobile, rod-shaped organism, usually with enlargements at both ends. Probably *Spirochœta penortha* is a specific accessory causal agent, while a mobile fusiform is a constant secondary invader, doubtless playing some part in the pathogenesis of the disease. Except in artificial culture, *F. nodosus* cannot survive for more than a few days apart from lesions, of which there are three different types. It has now been possible to elaborate a plan of control of the disease which has been applied to several large sheep stations. Not only was foot-rot eradicated from these stations, but also they remained free during an epizootic in the neighbourhood.

Lamp-brush Chromosomes

PRE-TREATMENT with sodium hydroxide and urea on the salivary gland chromosomes of *Drosophila melanogaster* has been used by M. Kodani (*J. Hered.*, **32**, 147; 1941) to induce the lamp-brush effect previously obtained in the chromosomes of other organisms. The author finds that there are definite achromatic regions which contain little nucleic acid. By marking the *X*-chromosome with inversions it was possible to construct a lamp-brush chromosome map. The chromatic regions correspond with the chromosomes of Heitz in mitotic prophase and were considered to contain active gene loci. Heterochromatin within euchromatin regions differs from the heterochromatin at the proximal end. The heterochromatin in euchromatin regions corresponds in position with regions of the salivary gland chromosomes which contain few and small bands, and it is believed that mutant loci are located in the euchromatin region which is characterized by thick bands with a condensation of nucleic acid.

Earthquakes Registered in Australia

DURING the months of April, May and June 1941, seventy-two earthquakes were registered at the Riverview College Observatory, New South Wales. There were twenty-eight in April, twenty in May and twenty-four in June. The seismograms for all these have been interpreted. The greatest shock in April was on April 29 from an epicentre near 27° S., 118° E., which gave a ground amplitude of about 1/7 mm. at Riverview. In May the greatest shock was on May 17, which gave a ground amplitude of near 1/4 mm. at Riverview. The epicentre has been

provisionally estimated to be at 11° S., 166° E. The shock of May 4 was felt at Finke in central Australia, and another shock on May 4 also had its epicentre in central Australia. In June the greatest shock was on June 27, which also was felt at Finke in central Australia. The epicentre was at a distance of 1,680 km. from Riverview, where the maximum ground amplitude attained was near 1/4 mm. Microseisms hindered the interpretation of some of the records.

Nitrosyl Cyanide Salts

A STUDY of the metal carbonyls and nitrosyl carbonyls shows that, for all volatile compounds of this class, the effective atomic number is the same as the atomic number of one of the inert gases. The general tendency of elements to acquire the effective atomic number of the nearest inert gas apparently does not hold in the formation of simple compounds of the heavy metals, but the complex compounds of the heavy metals have an obvious tendency of this kind. This is shown in sodium nitroprusside, $Na_2[Fe(CN)_4 NO]$, and in the unusual manganese nitrosyl cyanide and cyanide salts $K_3[Mn(CN)_5NO]$ and $K_5Mn(CN)_6$, in which the existence of the complex ions is related to the stabilizing effect of the effective atomic number of 36 (krypton). These salts were prepared by Manchot and collaborators in 1926–28, and the method of preparation of the nitrosyl cyanide has been improved by A. A. Blanchard and F. S. Magnusson (*J. Amer. Chem. Soc.*, **63**, 2236; 1941), who have also recorded its reactions. Attempts to prepare analogous nitrosyl cyanides of cobalt, $K[Co(CN)_5NO]$ and $K_2[Co(CN)_5NO]$, were not successful.

Properties of Visual Purple at Low Temperature

THE discovery that visual purple is soluble and stable in a solvent made up of 75 per cent glycerol and 25 per cent water by volume, has enabled E. E. Broda and C. F. Goodeve (*Proc. Roy. Soc.*, A, **179**, 151; 1941) to extend the range for experiments below 0° C. At the temperature of solid carbon dioxide such solutions assume a glass-like consistency and remain perfectly homogeneous and brilliantly clear. Even at liquid air temperatures no crystallization occurs, although the great number of minute cracks developed scatter the light and prevent spectroscopic investigations. At room temperatures the spectrum is identical with that of the aqueous solution. At −73° C. the peak of the absorption curve is higher and narrower than at room temperature and it is shifted towards longer waves. The product of photodecomposition at −73° C. has a spectrum independent of *p*H and is at low temperatures thermostable and photostable. Thermal decomposition to indicator yellow occurs at room temperature. The primary product appears to be identical with transient orange. The quantum yield of the photoreaction at low and at room temperature are of the same order.

The Electronic Charge

A NEW determination of e has been made in the University of Melbourne by V. D. Hopper and T. H. Laby (*Proc. Roy. Soc.*, A., **178**, 243; 1941) using an oil-drop method in which the electric field is horizontal. The oil drops used were larger than those used by previous experimenters, and the velocity of fall and of movement in the direction of the electric field could be estimated with satisfactory accuracy. Assuming $\eta_{23} = 1830 \times 10^{-7}$ C.G.S. units, the value of e obtained was $(4{\cdot}8020 \pm 0{\cdot}0013) \times 10^{-10}$ E.S.U. (see also NATURE, **145**, 932; 1940). In work in progress, it is hoped to improve the precision of measurement of the viscosity of air by using a method suggested by Fabry and Perot. Laminar flow of air between optically flat disks is involved.

A Photographic Survey of Galactic Clusters

IN two earlier papers (*Mon. Not. Roy. Astro. Soc.*, **100**, 387, and **101**, 89) George Alter described his method of investigation of galactic clusters, and a summary of the first of these appeared in NATURE, **141**, 810 (1940). Alter returns to the subject in a third paper with the above title (*Mon. Not. Roy. Astro. Soc.*, **101**, 5, 6) which deals with seven further clusters, six of which are situated in a rich Cassiopeia region. The other cluster, N.G.C. 225, is situated outside and in front of a dark patch, and an absorbing cloud is indicated by its position in a dark patch and also by an irregularity in the range of distant moduli. Some uncertainty concerning the identification and co-ordinates of N.G.C. 133 and 146 is clarified and it is shown that the former is not really a cluster but only an accidental grouping of a few stars, while Anonymous appears on visual comparison as a cluster very similar to its neighbour N.G.C. 146. The distances found in this recent investigation are generally smaller than those previously determined; explanations can be found from the fact that in the latter case the distances were found by mere inspection of the photographs, without knowledge of spectral types or colour index, but with various assumptions as to cluster diameters and magnitudes. Tables have been prepared which show the co-ordinates and photographic and photovisual magnitudes of all measurable stars within the cluster regions under investigation, but unfortunately these cannot be printed owing to shortage of paper. Those who are specially interested can obtain copies by applying to the Norman Lockyer Observatory, Sidmouth.

Stellar Photo-electric Photometry

IN the past decade the attention paid by astrophysicists to spectrophotometry with the photoelectric cell has increased as the importance of the results so obtained became evident. Hitherto, however, the observations have been confined to two broad spectral regions, usually overlapping, and defined somewhat loosely by the characteristics of two colour filters the choice of which has been dictated more by the response of the photo-cell used than by the astronomical requirements. A recent paper by J. S. Hall, however (*Astrophys. J.*, **94**, 71; 1941), describes a method of working in which emphasis is put on the definition of the spectral energy admitted to the cell. From the grating spectra of stars formed in the focal plane of the objective, two movable slits segregate definite wave-length regions which are then reflected into the photo-cell. The paper gives more than 1,300 heterochromatic magnitudes of 67 bright stars measured in this way at as many as 13 spectral regions from 4500 A. to 10,320 A. Such measurements, especially if they can be extended to fainter stars, will give invaluable information on the extent to which colour temperatures depend on the spectral region in which they are measured, as well as on such related subjects as the effect on stellar colours of intrinsic luminosity and of selective interstellar absorption.

A STRAIGHT-GROWTH METHOD OF AUXIN DETERMINATION IN PLANTS

By E. DOROTHY BRAIN

THE Avena method of estimating auxin in plants requires such technical perfection and specialized apparatus that it is rendered useless to workers who have no access to elaborate equipment. The method described below has been worked out under ordinary greenhouse conditions and, while it is fully recognized that it cannot yield such exact quantitative results as the Avena test method, it has proved of use in comparative work and with more fully controlled conditions suggests possibilities for finer quantitative estimations.

This is an upright-growth method in which pieces of the plant material to be tested are applied with lanoline to the top of cut pea shoots. Peas are grown in soil in pots. The variety used for these experiments was Danby Stratagem. Three seeds to a three-inch pot has been found suitable and the seedlings are grown in the light until they are three or four internodes high. The growth of the internodes is recorded separately. The seedlings are then placed in a dark box, of which the relative humidity is kept up to 100 per cent by the floor being covered with damp soil, and which contains a maximum and minimum thermometer. After twenty-four hours in the dark box the growth of the separate internodes of the pea seedlings is recorded and the peas are prepared for the test by cutting off the part which is still actively growing. Using a safety razor blade, the plants are cut at the node below which growth has just ceased and the height of the remaining stump is recorded as *cut height* (1) (see accompanying figure). A vertical millimetre scale is placed behind each pea and marked at the level of the cut height and the pot level. The pea stumps are replaced in the dark box for thirty to forty minutes to give time for any bleeding from the cut surface. They are then made ready to receive the test material by the top being dried with filter paper and then covered with a layer of lanoline on which the test material is placed. The

Table 1.

RESULTS FOR VARIOUS SEEDLINGS.

Plant used	Cut height (1) in mm.	Cut height (2) in mm.	Increase in mm.
Lupinus albus			
Hypocotyl segments 10 mm.	18·0	19·0	1·0
	20·0	21·0	1·0
,, ,, 5 mm.	14·0	15·0	1·0
	15·0	15·0	—
(Temperature 94°–60° F.)	13·0	14·0	1·0
top of epicotyl	18·0	20·0	2·0
	10·0	12·0	2·0
(Temperature 74°–58° F.)	16·0	18·0	2·0
Lupinus polyphyllus			
hypocotyl segments 5 mm.	20·0	21·0	1·0
	10·0	11·0	1·0
	8·0	9·5	1·5
	12·0	12·0	—
(Temperature 94°–56° F.)	9·0	9·0	—
Helianthus annuus			
hypocotyl segments 10 mm.	23·0	23·5	0·5
	12·0	13·0	1·0
	33·0	34·5	1·5
	15·0	16·0	1·0
(Temperature 88°–56° F.)	17·0	18·0	1·0
Phaseolus multiflorus			
top of epicotyl 15 mm.	30·0	31·5	1·5
	18·0	20·0	2·0
,, ,, ,, 10 mm.	40·0	43·0	3·0
	18·0	20·0	2·0
	29·0	31·5	2·5
(Temperature 80°–56° F.)	20·0	21·0	1·0
Control experiments	18·0	18·0	—
lanoline	16·0	16·0	—
	15·0	15·0	—
	21·0	21·0	—
(Temperature 80°–56° F.)	19·0	19·0	—

Relative humidity 100 per cent.

Table 2.

RESULTS FOR INDOLE-3-ACETIC ACID.

(1) Temperature 80°–56 F. Relative humidity 100 per cent, 0·25 c.c. 1 per cent indole-3-acetic acid in 0·5 gram lanoline paste.

Pea

Cut height (1) in mm.	Cut height (2) in mm.	Increase in mm.
33·0	35·0	2·0
17·0	18·0	1·0
35·0	38·0	3·0
30·0	31·0	1·0
15·0	16·0	1·0
22·0	25·0	3·0
10·0	10·0	—
22·0	26·0	4·0
17·0	23·0	6·0
18·0	19·0	1·0

(2) Temperature 72°–54° F. Relative humidity 100 per cent, 40 c.mm. blocks of 1 : 1, 1 per cent indole-3-acetic acid in 3 per cent agar.

Pea

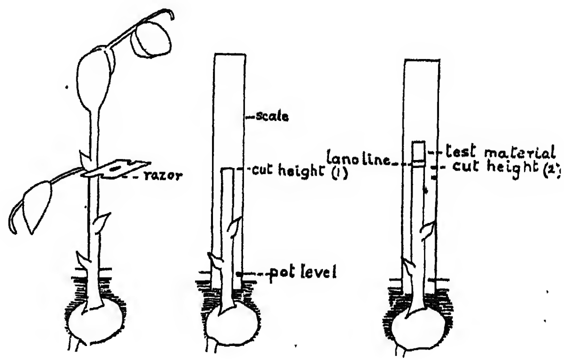
12·0	13·0	1·0
15·0	15·0	—
15·0	17·0	2·0
13·0	15·0	2·0
15·0	16·0	1·0
27·0	29·0	2·0
13·0	13·0	—
15·0	17·0	2·0

40 c.mm. blocks, 1 : 2, 1 per cent indole-3-acetic acid in 3 per cent agar.

12·0	13·0	1·0
17·0	18·0	1·0
31·0	31·0	—
18·0	19·0	1·0
16·0	17·0	1·0
15·0	16·0	1·0
17·0	18·0	1·0
15·0	16·0	1·0
13·0	14·0	1·0

Control experiments, 3 per cent agar blocks.

17·0	17·0	—
17·0	17·0	—
18·0	18·0	—
15·0	15·0	—
8·0	8·0	—
22·0	22·0	—



peas are then replaced in the dark box for twenty-four hours, after which they are removed and the *cut height* (2) is measured by the millimetre rule and the millimetre scale. The maximum and minimum temperature during the experiment are recorded.

More than two hundred tests have been carried out using hypocotyls and epicotyls of different species of seedlings, examples of which are shown in Table I. Control experiments were made by using portions from the base of hypocotyls where growth was known to have ceased and others with lanoline alone applied to the pea stumps. Definite increase in the height of the pea stumps was shown by the application of the actively growing plant material and this could be measured correctly to 0·5 mm. This increased growth is attributable to the amount of growth substance which diffuses out from the plant material applied on the lanoline which restimulates growth in the pea stump.

In order to attempt some standardization of this induced growth, experiments were performed with indole-3-acetic acid in one per cent solution (0·1 mgm. acid per litre). This was first applied in lanoline, a paste being made by mixing 0·25 c.c. with 0·5 gm. of lanoline. Results from this experiment were variable owing to the difficulty of obtaining an even mixture and equal applications to each pea. More experiments were made with the indole-3-acetic acid mixed with a 3 per cent agar gel. Mixtures of equal parts acid and melted agar and one part acid to two parts agar were made into blocks which were applied to the pea stumps. The blocks were made by sucking up the agar mixture into a straw, in which it cooled and set. Then blocks of the required length can be cut with a razor blade and in applying them to the pea stump the straw acts as a support for the agar block. The blocks used were 5 mm. long and approximately 40 c.mm. in volume, which is much larger than those used for the Avena test but of approximately the same volume as the segments of *Lupinus albus* hypocotyls, with which many of the experiments were performed, and a convenient size to fit on to the pea stumps. The blocks were placed on the pea on lanoline as described above.

Results recorded in Table 2 show that a block of 40 c.mm. containing 1 : 2 parts indole-3-acetic acid in 3 per cent agar would produce an increase of 1 mm. in the pea stump. Blocks made of 1 : 1 acid and agar produce greater increase but more variable results. It is, therefore, suggested that an increase of 1 mm. in the pea stump should be regarded as a standard for measurement of the amount of growth substance which has diffused out of the test material, one 'pea unit' being that amount of growth substance which diffuses from an applied block of plant material causing an increase of 1 mm. in height of the pea stump and is equivalent to the growth caused by a block of 1 : 2 indole-3-acetic acid (0·1 mgm. per litre) in 3 per cent agar at a temperature 72–54° F. and 100 per cent relative humidity.

According to Went[1] 0·5 per cent indole-3-acetic acid solution in a 10 c.mm. agar block, at 24°C., and 85 per cent relative humidity would produce 5° curvature in the Avena test, so that the results for the pea method show that an increase of 1·0 mm. in the pea stump would approximate to 5° curvature in the pea test.

[1] Went, F. and W., and Thimann, K. V., "Phytohormones", p. 41 (New York: The Macmillan Company, 1937.)

SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

The fifteenth annual report of the Department of Scientific and Industrial Research, New Zealand, covers the year 1940–41 and includes the Minister's statement, the report of the Secretary, together with reports of the research committees of the Council of Scientific and Industrial Research and of the work of the Plant Research Bureau, Wheat Research Institute, Magnetic Observatory, Dominion Laboratory Geological Survey Branch, and Metrological Branch*.

The Dairy Research Institute has been occupied with urgent problems relating to the storage and transport of dairy produce under war conditions, and particularly with the view of prolonging the keeping quality of dairy produce likely to be in storage for long periods and methods of packaging and processing butter and cheese to conserve shipping space and weight and packing materials. Special starter rooms embodying the Institute's recommendations for preserving the vitality of starters were erected by some fifteen dairy factories during the past season.

The work of the Plant Research Bureau during the year has been concentrated on minimizing losses in pasture, arable and horticultural crops by intensifying control measures, the maintenance of full supplies of certified pasture and crop seeds and the propagation and collection of important medicinal plants to help supply emergency requirements in Great Britain and locally. Attention has also been given to local substitutes for imported plant materials such as seaweed products like agar and carrageen, the most efficient methods of preparing and conserving supplementary fodders and the instructional and research work required by the administration of the Termites Act, 1940. A considerable amount of work has been carried out on linen flax. The Plant Diseases Division at Owairaka, Auckland, has tested a number of organic mercurials for control of *Corticium vagum*, and has examined a number of copper compounds against standard Bordeaux mixture and biological work on sulphur sprays and the testing of derris products. Spray investigations and demonstrations in the field of fruit research have also been continued by the Division, while other work has been directed to the study of the insects attacking timber in an endeavour to select those satisfactory for testing timber preservatives and timber treatments. Tobacco research has included further work on the investigation of mosaic and that at the Cawthron Institute on control of damping-off fungi with soil dressings gave promise of success. Use of Semesan and zinc oxide with seed did not give satisfactory results, although Semesan gave satisfactory control if mixed with the soil to a depth of ½ in. The outstanding

* New Zealand. Fifteenth Annual Report of the Department of Scientific and Industrial Research. Pp. 92. (Wellington: Government Printer, 1941.) 9d.

problems in fruit research have been concerned with methods of storing under the best possible conditions the surplus of fruit thrown on the local market when export stopped. This has involved resorting to orchard storage on a greatly increased scale to supplement cold storage facilities. Experimental work in co-operation with the Cawthron Institute has yielded valuable information regarding the optimum conditions of temperature and humidity in orchard stores, the best methods of wrapping and packing and the varieties and grades of fruit best suited for orchard storage.

Work at the Plant Chemistry Laboratory received a severe set-back through the destruction of the laboratory and a greater part of its equipment by fire during the year. Very good work has, however, been done under difficult conditions in supplying a considerable amount of alkaloidal material from perennial rye-grass to the Department of Agriculture for animal experiments in connexion with facial eczema studies and in obtaining chemical data on the digestibility or nutritive value of silage from selected pastures. Chemical studies on the effect of naphthylacetic acid on the composition of cuttings and on the relation of accessory substances such as auxines and vitamins to soil fertility has continued. In collaboration with the Mines Department surveys of minerals of strategic value and special economic importance in war-time have been intensified, including surveys of local resources of such minerals as serpentine, magnesite, oil shale, sulphur, sands and clays. A special committee was set up to co-ordinate investigations by the Department of Agriculture and Scientific Industrial Research, the Cawthron Institute and the Canterbury Agricultural College on the manufacture and agricultural value of a reverted phosphatic fertilizer obtained by incorporating ground serpentine with superphosphate.

The activities of the research associations servicing the tanners, the boot and shoe manufacturers and the wool manufacturers have been directed specially to war-time manufacturing problems, including the provision of satisfactory substitutes for imported materials which are not now available. Other investigations have been concerned with local substitutes for imported pottery materials, adhesives, agar and carrageen. The Physical Testing Laboratory, in addition to a large amount of work on physical testing and precision-instrument constructing, is extending its operations in regard to standards of reference for use in connexion with the manufacture of munitions.

The Chemical Engineering Section of the Dominion Laboratory has been largely occupied with the investigation of producer gas as an emergency fuel for motor vehicles, and its semi-commercial trials on the gas storage of apples to improve their keeping qualities for local consumption has yielded valuable data. Much chemical work has been done in connexion with a survey of national coal resources, and other work has been concerned with stone preservation and spray residues on cabbages, and investigations on casein paint and on the utilization of bentonite are also in progress.

The Geological Survey has carried out special geological and geophysical surveys for the Public Works Department in the Waikato in connexion with hydro-electric developments, and a re-survey of magnetic stations throughout New Zealand is being made to provide data required by the defence services.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, NOVEMBER 29

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 11 a.m.—Dr. G. M. Findlay will open a general discussion on "The Mode of Action of Chemotherapeutic Agents".

INSTITUTE OF PHYSICS (MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester), at 2.30 p.m.—Prof. M. L. Oliphant, F.R.S.: "Physics in the United States and Recent Practical Applications of Nuclear Physics".*

MONDAY, DECEMBER 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Capt. R. Hamond: "Through Western Tibet in 1939".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Curtin Cosbie: "Brewing, the Story of a National Industry"—3: "Brewing Research" (Cantor Lectures, III).

TUESDAY, DECEMBER 2

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, DECEMBER 3

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (Joint Meeting with the Society of Public Analysts) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 11 a.m.—Mr. A. L. Bacharach: "The Nutritional Bases for Fortification of Foods".

THURSDAY, DECEMBER 4

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. Benjamin Farrington: "The Hand in Healing: a Study in Greek Medicine from Hippocrates to Ramazzini".

FRIDAY, DECEMBER 5

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "Some Problems in Wartime Horticulture with particular reference to Vegetable Production".

SATURDAY, DECEMBER 6

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Dr. W. G. Wearmouth: "Physical Problems in the Plastics Industry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (ungraded) in the Department of Biochemistry—The Registrar, The University, Liverpool (December 6).

TEACHER OF ELECTRICAL ENGINEERING AND ALLIED SUBJECTS in the Cambridgeshire Technical School—The Education Secretary, Shire Hall, Cambridge (December 8).

ENGINEER for the Sierra Leone Public Works Department—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E. 338).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 578, Vol. 231: The Heart of the Salamander (*Salamandra salamandra*, L.), with Special Reference to the Conducting System and its Bearing on the Phylogeny of the Conducting Systems of Mammalian and Avian Hearts. By F. Davies and E. T. B. Francis. Pp. 99–130+plates 7–8. (London: Cambridge University Press.) 7*s*. [411

The Amazing Insects. By G. E. O. Knight. Pp. 16. (London: Insecta—Mammalia.) 1*s*. [411

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NATURE

SATURDAY
Dec. 6, 1941

THE SPIRITUAL VALUE OF RESEARCH

SCIENTIFIC workers are adding here and there to human knowledge, and from time to time it is opportune to take stock in science, to ask whether the efforts are directed towards the best ends or whether we are largely chasing our own tails in working on details of established problems.

For the purpose of this inquiry a distinction may be drawn between pure and applied scientific research, though admittedly it is improper to do so. In the first place, it is legitimate to wonder whether the best brains seek scientific work as a career. Differences in the work and in the environment of the work demand different traits of temperament and character. The level of intelligence which the honours training ensures does not necessarily mean the possession of great inventive capacity or powers of imagination. There is rather a tendency to sneer at the man engaged in utilitarian science ; one sees such expressions as the greed for gain, the prostitution of science, blatant insistence on profit making. Such accusations are frankly not true ; the scientific worker in industry, even if he has never published a paper in a scientific journal, can be and often is at least the equal of the academic worker.

The point is best illustrated by reference to the United States, where there are as many and as competent men of science at work in the universities and colleges as in Great Britain. In addition, most Americans will agree that there are as fine or an even finer set of brains engaged in perfecting the new discoveries and finding practical uses for them of benefit to man. Very often the practical use of something new has to be forced on man : he is told by means of advertisement that here is something that he really wants, whereupon he begins to buy it, but before long something of real value results from the development : this is happening more and more often. The chemists, for example, sought long to find a use for butyl alcohol : in the end, spray paints were discovered ; not only are they of the greatest value to the motor-car industry, but also they have revolutionized the paint industry. There is nothing ignoble in making something useful, while in regard to profit, large or small, unless an article can be sold at a profit the inventor can neither live, make experiments, nor even induce anyone to undertake manufacture. President Roosevelt, speaking of a report of the National Research Council to Congress, has said it "presents a clear record of how successfully we have translated our old time Yankee ingenuity for invention into American genius for research".

Some of the facts relating to the United States are striking. Thus in 1940, 2,200 industrial corporations maintained 3,500 research laboratories

employing 70,000 workers at a cost of seventy-five million pounds. In these, particular emphasis is directed towards personal qualities of the prospective employee as distinguished from scholarship. Creative urge, receptiveness to new ideas and intellectual integrity are particularly important. It is such men and their gifted leaders who have made the wholly synthetic textile 'Nylon', at a staggering experimental cost which it will take a long time to recover from profits. Nylon bids fair to make the world independent of Japanese silk. In addition, all sorts of new uses, perhaps of equally outstanding value, will be found for the fibre.

Nothing which is said here indicates any desire to check pure research; it is realized that great discoveries come only seldom and then perhaps after years of patient groundwork, also that "the wind of genius bloweth where it listeth". A difficult problem such as that of cancer must be attacked from many sides; a tiny advance here may lead to definite progress elsewhere.

There is, however, much to be gained by planning a research. In industry it is of value occasionally to review a research problem on its completion, so as to see how much time could have been saved if none but useful experiments had been undertaken: often the necessary time is but a small fraction of the time actually spent. Research expenditure is usually roughly proportional to sales: it becomes difficult to know how much money to allocate to subjects which are far in advance of the specific problems of an industry. But to-day American 'big business' men firmly believe in research and believe that they would suffer seriously were it discontinued. Chairmen produce slogans when they talk to shareholders: "The fountain of youth for a corporation is technical research which has been properly organised for profit." "Every discovery has a tremendous background. . . . Every discovery in turn is a link in the chain leading to further development." "The products of to-day's researches are a base for to-morrow's orders." "The price of progress is research which alone assures the security of dividends."

Speaking of the glass industry in the United States, in which the over-riding control is exercised by one or two organizations, Prof. W. E. S. Turner has said that "so far from resting on the position acquired, they appear to be intent on strengthening the position by research development work on a considerable scale".

It must not be forgotten that many research problems are so costly nowadays that only the largest organizations can finance them. A technical research is no longer a problem for a single man with two or three helpers; it may involve a team of a hundred scientific workers and necessitate the building of a small experimental factory.

Research expenditure in such industries as food, textiles, leather, forest products has lagged behind that in the oil, rubber, chemical and electrical industries; there is, however, just as much room for it and as much reward awaiting success. Research need, indeed, should not be confined to process inventions but extended by co-operation between management and labour to fatigue, industrial psychology and related matters. To employ each worker in a way that best suits his capabilities, to enable him to perform a full day's work with a minimum of fatigue, are all desiderata which should make the strongest appeal to any well-managed firm.

Although what has been said above had direct reference to science in industry, it also applies fundamentally in so-called pure science. As Sir Henry Dale pointed out in his presidential address to the Royal Society (p. 678), the work of the Medical Research Council and its sister bodies is evidence of the value of research under careful control exercised on behalf of the Government.

If it be accepted that no man is happy unless he works, and that the work should be worthy of the effort, then the need to ensure that each of us is enabled to do his best in congenial work is beyond question. The worker has the obligation to become fully trained, to be patient until the opportunity arises to step into his ideal post and to render service such as will justify his salary, the oncost on his job and provide something for the future development of his industry. It may take years to find out whether one has chosen a career wisely; there may be steps to be retraced, adjustments to be made, but so long as there is a spiritual desire to make good, success, however it may be defined, can only be round the corner.

There is constant complaint about the apathy of the public towards science, its ignorance of science; but perhaps the fault is as much on the side of men of science as that of the public. In general, men of science fail to tell the public what is going on; why, for example, margarine to-day is the equivalent in most respects of butter, whereas twenty years ago it was much inferior; the public cannot find this out for itself.

Men of science surely have a duty to the public to learn to write more simply, so as to bring home to a far larger audience than is reached at present what science means and what it is doing. Until this can be done, no complaint of the neglect of science is justified. We may have smashed the atom and realized the alchemists' dream by the manipulation of the bits, but it does not make sense when we let the lay newspapers hint that gold from lead has become a practical possibility.

AGRARIAN PROBLEMS OF MEDIEVAL EUROPE

The Cambridge Economic History of Europe from the Decline of the Roman Empire
Edited by Prof. J. H. Clapham and the late Prof. Eileen Power. Vol. 1: The Agrarian Life of the Middle Ages. Pp. xvii+650. (Cambridge: At the University Press, 1941.) 30s. net.

THE history of which this is the first instalment is not only a co-operative, but also an international work. The fifteen contributors to the present volume represent schools of history or economics in France, Belgium, Germany, Switzerland, Austria, Poland, Russia, Finland, Sweden, Jugoslavia, Great Britain, and the United States. The result is a series of essays in which the agrarian development of most European countries is traced by specialists, familiar alike with the original materials and the scattered literature which has arisen around them. The task of assembling these articles under war conditions must have been very difficult, and all English students of economic history should be grateful to the editors whose resolution has made it possible. The gratitude of those who use the volume will be deepened by the knowledge that Prof. Eileen Power, who planned it and prepared much of it for the press, died with tragic suddenness while the work was still in the printers' hands.

No general synthesis of results is attempted in this volume. The attempt would in any event have been unprofitable, for research in the field as a whole has not yet reached a point at which large-scale conclusions can safely be drawn. It is still possible for specialists to differ abruptly from one another on the fundamental question of the extent to which the economic life of the Roman Empire survived the barbarian invasions of the fifth and sixth centuries. What can be undertaken is a survey of tendencies, and in two articles this limited aim is brilliantly achieved. Without any evasion of controversial issues, Marc Block traces the evolution of seignorial institutions in an essay which is not only learned, but also singularly clear, and at all salient points, convincing. The introductory essay on the settlement and colonization of Europe, by R. Koebner, is a masterly description of the first discernible stages in the economic development of western Europe, and of the historical and physical factors which by their interplay determined its course. The article is of especial interest through the judicious use which it makes of the English evidence, which previous workers have often under-estimated.

The articles on individual countries form a set of regional surveys which will be very useful as an abstract of existing knowledge. The essays which deal with the remoter European States fill a gap of which English students have long been aware. For a considerable time to come, readers who wish to know about agrarian conditions in medieval Spain, Poland, the Scandinavian countries, Russia, or the Byzantine Empire will be well advised to turn in the first place to the essays, and then to the bibliographies, printed here. The fact that many of these essays are hard to read is partly due to the difficulty of explaining technical details in a narrow space, but still more to the uncertainty which overhangs much of the detail itself. For most of the countries of northern and eastern Europe, the material available for economic study is unevenly distributed both in space and time. Outside England and the regions covered by the Carolingian Empire, there is remarkably little evidence which bears directly on the origins or the early stages of economic evolution. In Denmark, for example, the oldest documentary authorities are of the late eleventh century, and the terminology of medieval records is so elliptical that scholars differ widely about its meaning at essential points. As important changes in the methods of land distribution are known to have occurred in medieval Denmark, it is not surprising that few definite facts can be given about the primitive Danish economy.

On the general question of agrarian origins, it is interesting to see that scholars in all countries are tending to use the evidence of place-names as a clue to the character of early forms of agricultural association. The evidence has been unduly neglected in the past. But the interpretation of place names, even when their original forms have been ascertained, is beset with difficulties, and there are articles in this volume in which the results of place-name study are used with more assurance than would be felt by those who have worked on these problems from the linguistic side.

All this means that medieval economic history, as yet, falls far short of scientific precision. The patterns of agrarian life, painfully reconstructed by the modern student, were evolved, even more painfully, by generations of peasants preoccupied with the task of wringing subsistence year by year from land which, on any flagging of effort, would revert to wilderness. The expedients which they adopted in the attempt to escape from the compulsion of their environment varied within each country from place to place. The economic historian, in recording the result of their efforts,

is describing the average of a vast number of experiments. The writer comes nearest the truth who realizes most clearly the number and range of the variations from this mean. Every contributor to this history brings out the diversity of the conditions with which he is dealing. But the limited space at the disposal of each writer has meant that significant variations of the agrarian system are sometimes understressed. It would scarcely be gathered from the essay which deals with England how many exceptions there are to the types of agricultural economy which historians tend to regard as characteristic of different parts of the country.

On this point, it may be suggested that the reader would have been helped by a slight addition to the content of the volume. The importance of money as a solvent of agrarian custom is recognized on all hands. But the treatment of currency problems is reserved for a later portion of this "History". The result is that the present book contains no general discussion of the conditions under which a 'money economy' came into being in different European countries. The need for a survey of these conditions is one among many reasons for hoping that the second volume of this valuable "History" will not be long delayed.

F. M. STENTON.

THE CONTINENTAL SHELF

Atlantic Submarine Valleys of the United States and the Congo Submarine Valley

By A. C. Veatch and P. A. Smith. (Geological Society of America, Special Paper No. 7.) Pp. xvi+101+10 plates. (New York: Geological Society of America, 1939.) £1 10*s*. net.

The Origin of Submarine Canyons: a Critical Review of Hypotheses

By Prof. Douglas Johnson. (Columbia Geomorphic Studies, No. 3.) Pp. ix+126+4 plates. (New York: Columbia University Press; London: Oxford University Press, 1939.) 15*s*. 6*d*. net.

DURING the past fifteen years, the methods by which hydrographic surveys are made have fundamentally changed, and both the accuracy attainable and the speed of working have greatly increased. These changes are due partly to the introduction of the echo sounder and partly to new methods of position finding when out of sight of land. The paper by Veatch and Smith, with its accompanying charts, represents one of the first products of these technical advances, and gives us, for the first time, a survey of an extensive area out of sight of land in which the positions of the soundings can be relied on sufficiently for steep bottom forms to be contoured. The area treated is off the eastern coast of the United States from Cape Henry to Georges Bank. The charts are on a scale of 1 : 120,000 and show all the thousands of soundings on which the contours are based.

As is well known, the surface of the continental shelf on the Atlantic seaboard of the United States is a relatively featureless plain sloping very gently seaward. Beyond the 100 fm. line, however, the gradient suddenly steepens to about one in forty, and large irregularities appear in the topography. It is in this area, between the 100 and 1,000 fm. lines, that the main interest of the work lies. Unfortunately, the spacing of the lines of soundings, although they are many times more numerous than in previous surveys, is too wide for the contours to be traced in a purely mechanical way. The authors have therefore assumed that the bottom forms are similar to those due to stream erosion on land, and have drawn a set of contours satisfying the observed soundings and depicting an erosion surface. The assumption considerably restricts the form of the contours, for it requires the gradient of a valley bottom never to change sign and all valleys to branch upwards. The authors explain very clearly what they have done and say that they have made numerous attempts to fit other types of topography without success. To establish whether or not the irregularities shown by these soundings do represent a stream-like pattern is among the most important problems of geology, and is one that could in happier times be easily solved by a detailed examination of a small area. From a somewhat superficial examination of the charts it appears that, while not every irregularity shown by the contours is certainly present in Nature, yet it is established that the topography consists of ridges and valleys running up and down the slope.

Whatever may be the form of the minor relief on the slope, the present charts leave no doubt as to the form and position of those major features that have been called submarine canyons. Nine major canyons occur in the area covered by the charts. The largest is the Hudson canyon, which is about fifty miles long, six miles wide and has a maximum depth of 3,700 ft. below its rim. These canyons are cut as nicks into the edge of the shelf and do not extend more than a few miles inside the 100 fm. line. They are not connected in any striking way with the present rivers on land.

Veatch and Smith, having convinced themselves of the existence of a stream-like pattern, believe that this pattern has actually been cut by streams. They boldly lower the sea 12,000 ft. some 25,000 years ago and return it to its present level so recently as 3000 B.C.

Although we have only recently acquired a detailed knowledge of the form of the canyons, their existence has been known for many years, and a great body of comment and speculation has accumulated concerning their origin. The main object of Prof. Johnson's monograph is to review critically this obscure and scattered literature. The canyons must either have been formed under the sea or out of it. If the latter, then either the land must have been raised or the sea lowered. The changes required are so large, so widespread and so recent as to reduce the argument almost to an absurdity.

If the canyons were formed under the sea, then either they were eroded by some kind of submarine current or else they were undermined by submarine springs. The hypothesis that mud-laden currents were responsible for excavating the canyons has been strongly urged by eminent authorities, but is rejected as inadequate by Prof. Johnson. He believes that undermining by submarine springs is the primary agent in excavating the canyons, and supports this view with arguments from a wide variety of natural phenomena. Quite apart from the correctness or otherwise of the views expressed, the whole book compels the reader's admiration by the extent and variety of the sources from which he has drawn his information.

Actually, this view of the genesis of submarine canyons has much to commend it. It requires no catastrophes, it does not need any straining of the laws of physics, or any very exceptional circumstances. The principal doubt is whether the structure of the shelf is such that artesian conditions are possible on the slope. At first sight this would require the slope to be a fault or erosion feature, which would be an unwelcome assumption to many. More careful consideration suggests that this may be avoided, and the more attractive idea of a lens or delta-like accumulation of sediments retained. Among other possibilities the author suggests that the water for the springs might be that expelled from the sediments during compaction.

However these doubtful matters may finally be decided, it is clear that the present data are only a beginning of a vast undertaking, and that the unravelling of even the outlines of submarine geology will occupy many years. Further improvements in technique will be necessary to extend the work to deep water. This will require the solution of many difficult and interesting problems in physics, seamanship, and geology, and will require the close co-operation of experts in these matters.

E. C. BULLARD.

CONCEPTS OF ELECTRICITY

Introduction to Electricity and Optics

By Prof. Nathaniel H. Frank. Pp. xii+398. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 24*s*. 6*d*.

THIS book has been written as a text-book for second-year students at the Massachusetts Institute of Technology. "The goal to which it aspires is a compact logical exposition of the fundamental laws of the electric and magnetic fields and the elementary applications of these laws to circuits, to a study of the electrical and magnetic properties of matter, and to the field of optics." A slight acquaintance with the calculus and a knowledge of elementary physics is assumed on the part of the student.

There are no descriptions of apparatus or experiments or historical accounts of the development of the subject, and the physical principles have not been used simply as pegs on which to hang mathematical problems. An account of the principles on which the theory is based, of their meaning and the way they are related to one another, is aimed at. In fact the author is trying to teach physical instinct directly by an unhurried and in some respects very skilful presentation of 'key' facts and calculations, and not by letting the student acquire it unconsciously by drill in calculation and experiment. Elementary alternating current circuits, Maxwell's equations of the electromagnetic field, the theory of dispersion and Planck's radiation law are done in an elementary manner, but there is no reference to, for example, the ballistic galvanometer. There is no obsolete or obsolescent matter in the book, but it is not too modern; the quantum is barely mentioned. In some respects the treatment is very unusual, as for example in magnetism, where the magnetic pole is relegated to a subordinate position. There are collections of good problems, but the solution of some will require help from outside the book.

The book is to be regarded, therefore, not as a conventional text, but in conjunction with the

author's companion book on mechanics and heat as a text-book on physics from an unusual point of view. It would probably be very helpful to second-year physics classes at universities where the physics is ahead of the mathematics, and generally where physics is being combined with chemistry and not with mathematics. It is undoubtedly a book for the college library. Teachers will enjoy the freshness of outlook, but may disapprove of the selection of matter. The book is well produced, but the price is high.

R. A. HOUSTOUN.

BEHAVIOUR OF IODINE IN THE BODY

The Endocrine Function of Iodine

By Prof. William Thomas Salter. (Harvard University Monographs in Medicine and Public Health, No. 1.) Pp. xviii+351. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 3.50 dollars.

ANY work dealing with the behaviour of iodine in the body is bound to be mainly an account of the physiology of the thyroid gland. It is chiefly for this that biochemist and clinician alike will consult the book under review. Neither will be disappointed; for the author shows himself to be equally at home in the laboratory and in the ward.

It is evident from the title, however, that the author considers that iodine is concerned also in the workings of the other endocrine glands. It must be admitted that the evidence for any direct connexion is a little thin; but in so far as the endocrine glands are mutually dependent, they may all be said to participate in a manner in iodine metabolism. Their mutual relationships are well discussed; and in expounding the view that all the endocrines are dependent on and controlled by each other (rather than all directed by the pituitary) Dr. Salter is able to coin a new and topical phrase—"the pituitary-thyroid axis"—which, with its variants, may in time replace Cushing's older orchestral simile.

Interesting as these speculations are, they have at present no direct clinical application; the instrument which the clinician most hopes the biochemist will provide him with is an unequivocal method of determining the amount of circulating thyroid hormone in the blood. Given this instrument, many of his problems would automatically be solved, and many questions settled which he can now only speculate about. The introduction of methods of estimating iodine in small quantities of blood has brought that goal within sight; but before it can be attained, an improved technique of separating the active from the inactive iodine is required.

The form in which the thyroid hormone circulates n the blood is not at present known, but it may be presumed to be a protein, containing thyroxine among its amino acids. Therefore, so far as the hormone is concerned, only that fraction of the plasma iodine which is bound to protein is of interest. Iodine is bound, however, to the proteins of the plasma with varying degrees of intensity; how much this linkage is a matter of chemical combination, and how much of adsorption, is far from clear. The greater part of the protein-bound iodine can be extracted with alcohol or acetone, the amount extracted depending largely on the thoroughness of the extraction. The amount so extracted by various arbitrary procedures of this type has been termed by many investigators 'organic iodine', and taken to represent the hormone itself. This premature assumption is largely responsible for the confusing results reported in the literature.

Although recognizing the many possible fallacies, the author has given close consideration to all the reported values for blood iodine in health and disease. In spite of the technical weaknesses, all investigators have found that the level of the part of the iodine which is most closely related to protein corresponds roughly to the expected level of thyroid hormone. Thus plasma organic iodine is low in myxœdema and high in thyrotoxicosis, and in the latter disease it tends to return to normal after appropriate treatment of the patient.

Dr. Salter has himself confirmed these general conclusions. His method is to estimate simply the iodine which is precipitated with the plasma-proteins. (He suggests, for future use, a further subdivision—after alkaline hydrolysis—into thyroxine-like and di-iodotyrosine-like fractions.) The exceptions and difficulties are frankly dealt with, and the author makes it clear that the protein-bound iodine cannot be taken to be identical with the thyroid hormone. He describes, for example, a marked rise in protein-bound iodine on administering potassium iodide to cases of myxœdema. Nevertheless he regards the test as already of some practical use in diagnosis; although the ten cases described to illustrate this point may leave the clinician wondering whether these particular problems could not have been solved by less elaborate methods.

The recent work on the administration of iodine 'labelled' with radioactive isotopes is fully described. The most useful isotopes appear to be those of mass 128 (with a half-life of 25 minutes) and of mass 131 (with a half-life of 8 days). The work so far done on this promising subject has accomplished little more than the verification and amplification of conclusions reached by the older methods; the astonishing rate of uptake of iodine by the thyroid (particularly when hyperplastic) is illustrated by the finding that, after intravenous injection of a radioactive iodine, the peak of its concentration in the gland is attained within 10–15 minutes. The author touches on the therapeutic possibilities of radioactive iodine, by which theoretically a brief bombardment of tremendous intensity could be delivered from within the thyroid itself by what should be attainable doses. A short section describes the biological effects of the newly discovered element No. 85, which seems to have in common with iodine an affinity for the thyroid.

Other topics dealt with in this book include the artificial iodo-proteins, iodine balance and the relation of the nervous system to iodine metabolism; while an appendix gives details of the methods employed by the author to estimate and fractionate iodine in biological material. The discussion of the varied problems concerning the behaviour of iodine in the body is conducted throughout with the easy competence of one who is familiar with every by-way of his subject. The new series from the Harvard University Press could have no better introduction than this scholarly work.

W. R. Trotter.

A NATURALIST IN THE HIGHLANDS

Highland Gamekeeper
By Dugald Macintyre. Pp. 246+8 plates. (London: Seeley, Service and Co., Ltd., n.d.) 12*s*. 6*d*. net.

It is a relief in times of war and stress to turn for relaxation to books written of Nature, lofty and serene. "Highland Gamekeeper" brings to the mind happier days, for it is written by one whose whole life has been spent out of doors, studying wild birds and wild animals. The author comes of old Highland stock; his great-grandfather, Allan Macintyre, was Kintyre's last bard and foxhunter, and we are told that the immortal Gaelic poet, Donnchadh Bàn nan Oran, Duncan Ban Macintyre (who, as is known, was a natural poet of the hills and no scholar), came to the author's ancestor Allan to have his poems written out.

With this ancestry there is little wonder that the author from his early years should have found himself a keen observer of Nature. We follow him through early to mature years, when he volunteered for active service in France in the War of 1914–18—he gives a vivid picture of shooting game over a recent battle-field and seeing a snipe which he had put up driven back to him by a peregrine falcon—down to the present day when from his home in Perthshire his observant eye notes the poaching kingfishers of the Earn and the strong-flying blackcock in the high-lying glens of the strath.

There are some valuable observations in the book. Who, for example, has seen a pair of wild peregrines bathing? On p. 59 Mr. Macintyre gives a vivid picture of this, for the peregrine to him is almost as familiar as the sparrow to less fortunate folk. A crime of the great black-backed gull is brought home to us (p. 102) in a manner which loses nothing through its simple terseness. But the author's outstanding achievement was his discovery (p. 107 *et seq.*) that curlews periodically eject the epithelial lining of the gizzard. He describes how he was able to convince the sceptics that this remarkable event did indeed take place. He writes:

"The discovery was made after I had examined numbers of curious little pouches which I saw lying in the pools of a marsh. Thousands of curlew used that marsh as a roosting-place, and I at first supposed that the queer objects were partly digested turnip leaves. The finding of a newly-shed pouch containing coarse white quartz grit led to my sudden recognition of the fact that the pouches were really the cast linings of curlew gizzards."

It was perhaps natural that the authorities at first were disinclined to accept his discovery, but:

"I forwarded about fifty shed gizzards to the FIELD office, together with several newly shot curlew for dissection, and the fresh gizzard-linings of other curlew, shot and dissected by myself. In the FIELD of the following week two authorities to whom the question was referred, Mr. R. H. Burne, of the Royal College of Surgeons, and Dr. H. Hammond Smith, pathologist to the FIELD, accepted my discovery as a new and true one, and Mr. J. E. Harting, the Naturalist Editor, quoted

the following excerpt on gizzard-renewal from Professor Newton's 'Dictionary of Birds': 'As a rule the cuticle (gizzard lining) is continually wearing away and being reproduced, but many cases are known in which most of the lining is suddenly cast off and ejected through the mouth'."

The author adds:

"I often heard curlew having long spells of coughing by night, but only understood what that meant after my discovery. The function of stomach-renewal takes place in early autumn, and it is in September or early October that one finds newly-shed pouches."

Mr. Dugald Macintyre is a keen fisherman, and has found that an effective lure for seatrout in the lower pools of a river at dusk is small saithe flies. I myself have caught saithe when fishing for sea-trout in the tidal waters, and have known of one occasion when a silvery herring snatched the fly and was landed.

The author narrates (p. 136) an occasion on which a cold spell which visited Mull suddenly during October 1936 had the effect of causing stoats to turn white prematurely, and believes that the weather largely influences their change of colour.

SETON GORDON.

CAUSATION OF MENTAL ABNORMALITY

The Psychodynamics of Abnormal Behavior
By Prof. J. F. Brown, with the collaboration of Dr. Karl A. Menninger. (McGraw-Hill Publications in Psychology.) Pp. xvi+484. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 24*s*. 6*d*.

THERE are a number of faults which are common to introductory books on psychopathology. They are often written by those who have themselves but a smattering of the subject—in spite of the fact that it needs wide acquaintance with it to write easily in simple language. Such books usually deal with fundamental material, which the student could read with advantage in the original work, and so neglects the more recent advances. Finally there is often a gross bias in favour of one particular school of thought.

These faults have been avoided by the authors of the interesting book under review. It is an excellent introduction to psychopathology planned for the student, but the general physician will also find it of interest.

The writers take the organismic point of view as their basis and, although they have a strong psychoanalytic leaning, they are critical in everything they say and do not repeat simplified orthodoxy. For example, they state: "We need more precise definitions of our theoretical concepts. In our criticism of psychoanalytic theory we saw that, despite the very great genius of Freud and many of his followers, many of the concepts were ambiguous and not at the present time capable of either scientific definition or experimental evaluation. It is to be hoped that the collaboration of psychoanalysts and academically trained psychologists will bring about a sounder background for psychopathology." This broad-minded view is taken throughout the book. Everywhere the importance of psychosomatic factors is noted; for example, on p. 68 it is stated: "A discussion of the several types of mental abnormality indicates the presence of psychic factors in those usually thought of as purely somatic and of organic factors in those usually thought of as purely psychogenic."

The book is divided into five parts. Part 1 deals with the organismic point of view (the reaction of the individual in his environment), normality, abnormality, the nature of personality, the historical development of psychopathology and the psychosomatic problem. Part 2 describes symptomology, modern ideas regarding symptoms, abnormalities of the cognitive, motor and emotional processes. Part 3 deals with the theory of the genesis and structure of the personality. Part 4 gives an outline of psychiatry (including sexual abnormalities and genius). Part 5 suggests the future possibilities of the psychodynamic theory. It is this last part which is of most interest to the practising psychiatrist, since it is full of common sense and points to many fascinating developments.

The book is well presented, with excellent binding and good print. The style is clear and illustrated with diagrams. It should be easy for one who has had a little acquaintance with psychology to understand the theories presented, but naturally those who are studying medicine should augment it with a text-book of psychiatry, since the clinical descriptions are a little curtailed. The value of the book is enhanced by a full bibliography—there are eighteen pages containing some four hundred references, mainly of recent work. There are also good author and subject indexes which make the book a pleasure to use.

CLIFFORD ALLEN.

Assam Adventure

By F. Kingdon Ward. Pp. 304+16 plates. (London: Jonathan Cape, Ltd., 1941.) 12*s*. 6*d*. net.

THIS is the kind of book that makes any flower-lover's mouth water. Kingdon Ward had, of course, to make the chance for himself. But what a chance it was! Wandering about in a flower paradise with nothing else to do but collect the most glorious plants. Thirty-nine rhododendrons—that alone should be enough to satisfy most plant lovers; but in addition such treasures as the Tibetan blue poppy, known all over the world as *Meconopsis baileyi* but now more accurately described as the *Meconopsis betonicifolia baileyi*; then ten different species of primulas and seven gentians. All these Kingdon Ward has through three journeys into south-western Tibet been able to introduce into cultivation in the West. It is a great contribution to the happiness of mankind and some little set-off to the present horrors of war.

We could have wished that Kingdon Ward had that other plant-collector, Reginald Farrer's, gift of description. But Farrer was a literary genius at describing flowers such as comes only once in two or three generations; and if he could not find the exact word to describe the colour or form of a flower he would deliberately coin a word for it. Kingdon Ward lacks that gift. But he has to some extent made up for it by the beautiful photographs with which his book is illustrated and which give us a fine impression of the kind of country in which the flowers are found. This is another important part of Kingdon Ward's work: he describes in detail the physical conditions of temperature or moisture, of shade or sunshine under which the many plants he has introduced to cultivators are found in their own native habitat. F. Y.

Historic Thorn Trees in the British Isles

By Dr. Vaughan Cornish. Pp. 94+9 plates. (London: Country Life, Ltd., n.d.) 8*s*. 6*d*.

DR. VAUGHAN CORNISH in his interesting study of historic thorn trees shows that their distribution in England coincides strikingly with the areas invaded in the south by the Belgic tribes from Gaul, and in northern England, by the Parisii, an adjoining tribe. From these tribes probably originated the cult of the thorn as a sacred tree—a cult still persisting in some remote districts in England, and common in Ireland, where the fairy trees are protected with superstitious reverence. The legend of the Glastonbury thorn gathered Christian associations around the thorn.

These cherished trees planted in later times as marks for assemblies of 'hundreds' or parishes, or as forest boundaries, and in some instances—as in that of the author's own inheritance, the Salcombe Regis Thorn—maintained by replanting to the present day, trace back in their story the history of their locality. Rectors of country parishes and anyone with an interest in the past and present of their district will find Dr. Vaughan Cornish's account of the thorn trees fascinating

The English May tree speaks of our past. May Day celebrations gather round it to-day. The fresh emphasis the War has given to the value of English trees should make this history of one of the most characteristic, timely.

The Nature of the Chemical Bond and the Structure of Molecules and Crystals

An Introduction to Modern Structural Chemistry. By Prof. Linus Pauling. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University.) Second edition. Pp. xvi+450. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1940.) 28*s*. net.

THIS book is lineal successor in a series of famous books dealing with structural chemistry from a physical point of view, the first of the line being G. N. Lewis's "Valence and the Structure of Atoms and Molecules". The first edition of Prof. Pauling's work was published two years ago. Its well-merited popularity led to the exhaustion of the first edition, and a second has now been prepared. This preserves practically the whole of the text of the original edition, but is improved and brought up to date by the inclusion of a further 20 pages, devoted mainly to the discussion of structures which have been studied by quantitative methods since the earlier edition was prepared for press. To a subsidiary extent the new matter consists of various expansions of the theoretical argument of the original work. The molecules of which the structures are discussed for the first time include the $Mo(CN)_8''''$ ion, which has the remarkable form of a triangle-faced dodecahedron, and *cis*-azobenzene; the new crystal structures include silicon disulphide and molybdenite.

Science in Peace and War

By Prof. J. B. S. Haldane. Pp. 229. (London: The Scientific Book Club, 1941.) 2*s*. 6*d*.

THE suspension of the *Daily Worker* has deprived the public of Prof. J. B. S. Haldane's weekly articles on scientific developments. The Scientific Book Club has, however, come forward and issued a new edition of his second set of collected articles. His new readers will find much entertaining material, for no one equals Prof. Haldane at casual human comment on the facts of science.

In connexion with the *Thetis* disaster, Prof. Haldane gives some very interesting details about his father's researches, which commenced with analyses of the air in the slums of Dundee in 1885 and 1886. Sometimes as many as eight persons occupied one bed in a single room, while in other cases there was no bed at all. His investigations convinced him that the high death-rate in overcrowded houses was not due to chemical causes, but to bacteria. He experimented on himself, and on his son. From the age of ten, Prof. Haldane used to accompany his father on research expeditions in mines. He tells us that his father always said that the most interesting physiological problems are those which arise in ordinary life.

J. G. CROWTHER.

INTERNATIONAL COLLABORATION AND FREEDOM OF SCIENCE*

By SIR HENRY DALE, C.B.E., F.R.S.

As we come to the end of another year we can see, as yet, no prospect for science of escape from the urgent preoccupation with the means of waging war. On the contrary, with the Union of Soviet Russia now locked in a supreme struggle for its own existence and the world's freedom, and with the United States of America rapidly directing its tremendous scientific and technical potential to the support of the same great cause, the diversion of science from its normal uses and objectives has spread right round the world. Yet even this grim necessity has brought with it some measure of compensation, in drawing closer the bonds of friendship between the men of science in the countries thus united in a common purpose. We in Great Britain received a tremendous encouragement, in the early months of this year, from the visit of President J. B. Conant and his associates to establish in London an office for the maintenance of regular and intimate co-operation between the war researches of our American colleagues and those which are here in hand. More recently, and in spite of all difficulties of communication, the sense of a common peril and a common determination is bringing us into a new and growing intimacy of collaboration with our colleagues of Soviet Russia. The organization of the science of the British Empire for war has brought to London already a number of distinguished colleagues from the Overseas Dominions, and we have heard of others who are on the way. It has been a particular pleasure to gather them here, in the house of the Royal Society, and to invite them to regard it as a centre and a rallying point for discussion of the means by which this new and closer collaboration, arising under the stimulus and the necessity of war, may be perpetuated and strengthened for the purposes of peace.

Generous gifts to the Society, during the year, from sister societies in America, have given further welcome evidence of the determination of our colleagues there to come to the help of British science in this time of need. The American Philosophical Society, founded in 1743 by Benjamin Franklin, with the Royal Society as his model, sent us ten thousand dollars "for the aid of science in Britain". They have confirmed our interpretation of their fraternal gift as betokening a desire to help us to preserve some measure of normal scientific activity in Great Britain during the War, and to keep alive the tradition of a free pursuit of knowledge for the benefit of all men. We have been able to find good use already for a large part of this benefaction, in the maintenance of a number of important researches, which war conditions had threatened to interrupt or to bring to an end. The American Physiological Society similarly sent the Royal Society five thousand dollars as a spontaneous contribution to the support of scientific publication in Great Britain, mentioning physiology as the subject to which they, as physiologists, desired us to give the first consideration. The Rockefeller Foundation, that truly international benefactor and promoter of natural knowledge, had already asked the Royal Society to be responsible for the distribution of twelve thousand five hundred dollars in aid of scientific publication in Great Britain in these difficult times.

Gifts such as these, welcome for their own intrinsic value and for the practical uses which we are readily finding for them, are even more welcome on account of the evidence that they bring of the feeling of comradeship between our American colleagues and ourselves. We can do no less, I think, than assure them of our determination that this closer sense of unity in aims and ideals, with them as with our fellow-citizens of the British Overseas Dominions, shall not be lost, but rather strengthened, when we face together the new problems which the end of the War will bring.

Though the first and imperative call on the science of all free countries is for the means of winning the war, to save the freedom without which science cannot in any true sense survive, we cannot put aside the duty of preparing for the part which science must play in rebuilding and maintaining civilization when peace returns. The Conference recently organized by the British Association on "Science and World Order" attracted more attention from the Press and the public than is usually given to scientific events and discussions; and it was, indeed, an impressive and significant fact that men of science from a dozen or more different countries, some far distant, should have found it possible now to meet, here in our war-scarred London, and to find the time and the impulse for such debate. We may offer our very sincere congratulations on the success of such an enterprise.

Many who took part in these meetings, held at a time when science finds itself conscript and organized as never before for the destructive pur-

* From the presidential address to the Royal Society, delivered on December 1.

poses of war, were clearly ready to support the view that it should be as fully organized by the Governments of a world at peace, for its proper purposes of enriching life and enlarging the opportunities of happiness for all men alike. There were not wanting voices, however, such as that of our Biological Secretary, to sound a warning of dangers which might be entailed by such fullness of association between science and government as others were advocating with conviction and enthusiasm. Freedom and opportunity, it was pointed out, rather than organization, provide the conditions for the highest types of research, and thus, in the end, for the greatest services which science can give to mankind. I find myself in sympathy with this view, and nobody here, I think, would suggest that it is usually possible to organize the researches which advance boldly into the unknown, and open new vistas to human understanding. Here we shall certainly not overlook the fact that, in the period between the two wars, important funds have been placed at the disposal of the Royal Society by a series of generous benefactors, to be administered for the support of researches over a wide range of subjects, in complete independence of any control by the State.

On the other hand, I think that it will be agreed that the remarkable development in Great Britain, since 1914, of the State support of research administered by the three Advisory Councils—the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council—normally in relation to the needs and the activities of a nation at peace, has taken place without any obvious detriment or danger to the freedom of science. The Royal Society's former function, of advising the Government directly on all scientific matters, and of organizing such systematic researches as were then undertaken in the public interest, has, of necessity, been shared and greatly diminished. We, as a Society, however, can fairly regard this development as, in many respects, a realization of the plans and the dreams of our predecessors here; and I do not think it fanciful to claim that our Society's traditions and standards have been still effective, through the influence of our fellows on the Advisory Councils and their Committees, and through the filling of their chief executive offices by men of our fellowship. As a whole-time research worker myself, since 1914, under the body which became the Medical Research Council, and the senior now in that service, I can bear grateful witness to the freedom of opportunity which can exist under an enlightened organization and control, exercised on behalf of the Government. I have no reason to suppose that the conditions are otherwise under the other Research Councils. Nor should we lose sight of the fact that a further large proportion of the free research of the country is now indebted to support from the State through grants to the universities, administered without any trace of detailed Government control.

While, therefore, the existing mechanisms for the support of science by the State are doubtless susceptible of improvement at one point or another, I find no reason to fear any threat to the freedom of science from them, or from any natural development on those lines. Nor do I fear it from a wider use of the organized application of science and scientific method to problems of public welfare; nor, again, from a more effective access of scientific knowledge to those responsible for government. A year ago Sir William Bragg told the Royal Society of the formation of the Scientific Advisory Committee to the War Cabinet, under the chairmanship of Lord Hankey, with the President and two Secretaries of the Royal Society as members *ex officio*. The representation of the Society has, indeed, been strengthened since then, and in a manner most welcome, by the fact that, though I have succeeded him *ex officio*, Sir William Bragg still gives his wisdom and experience to the work of that Committee, as an extra member.

There is one direction, however, in which I do find some reason to fear for the freedom of science. If science should become entangled in controversial politics, through the over-eagerness of its advocates and champions to invoke the sanction of science, or to claim its potentialities, in support of any special political doctrine, then indeed I believe that the threat to its freedom might become a real danger. Let there be no misunderstanding of my meaning. I am not abusing the privilege of this chair by using 'controversial' as an epithet to be applied to political opinions which I do not happen to share. I see danger if the name of science, or the very cause of its freedom, should become involved as a battle cry in a campaign on behalf of any political system, whether its opponents would describe it as revolutionary or reactionary. If science were allowed thus to be used as a weapon of political pressure, it would be impossible to protect science itself eventually from the pressure of sectional politics. If that should happen the dangers are, I believe, beyond dispute—the danger, for example, that fundamental researches, having no immediately practical appeal, would be allowed to fall into arrears through relative neglect; or the danger that the rigid standards of true science would be relaxed, by allowing the convenience of results for policy or for propaganda to enter into the assessment of their validity as evidence.

The Royal Society, with its firm and unbroken tradition of complete aloofness from political controversy, may still find it an important part of its function to keep watch and, if necessary, to stand without compromise for the right and the duty of science to seek the truth for its own sake, in complete freedom from any kind of extraneous influence. I hope, indeed, that there will never be need thus to invoke our tradition, in order to protect the freedom and the integrity of science from the enthusiasm and the advocacy of any of its friends.

PHYSICAL CONCEPTS OF THE MESON THEORY OF THE ATOMIC NUCLEUS

By PROF. W. HEITLER

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A SYMPOSIUM was recently held at the Dublin Institute for Advanced Studies, at which the present state of the meson theory was discussed. The present article discusses some of the views expressed, so far as they may be of interest for the general reader. Most of the views put forward in this article—if not generally known—have been discussed in recent years between Dr. H. Fröhlich and myself.

There is at the present time a veritable jungle of literature on the meson theory of the nucleus. Quite apart from the sometimes very extensive calculations, there exist at present two or three different meson theories—they differ essentially in the value attributed to the spin of the meson—and each is claimed to have great advantages. This in itself may be sufficient to stress the very preliminary character of the theory. The meson theory is entirely based upon the principles of quantum mechanics and of special relativity. Yet it could scarcely be expected that these principles will be sufficient to solve the problem of the elementary particles; something going far beyond relativistic quantum mechanics will be needed for this purpose. Nevertheless, the meson theory has already yielded a number of very valuable results and suggestions which can be considered as safe whatever the future development may be. We may perhaps compare the situation with that obtained by applying Lorentz's classical theory of the electron to an atom, treating the latter as a classical oscillator. The most striking feature, the existence of stationary states, cannot be understood in this way, but a number of other features, such as the absorption and scattering of light, can be understood quite well. Thus we must not expect that the present meson theory can be used to calculate exactly the binding energy of the deuteron, or that it can give any other quantitative results; but we can expect to obtain a large number of qualitative results and order of magnitude relations between the fundamental properties of the elementary particles. These properties turn out to be largely independent of the particular form we choose for the theory and can be explained by using general arguments only. (This does not mean that the development of the formalism is superfluous. It has indeed its merits—and very important ones—but a discussion of this lies outside the scope of the present article.)

The meson theory originated from an ingenious idea put forward by Yukawa in 1935. In order to describe the short-range forces prevailing between a proton and neutron, Yukawa introduced a new kind of field, φ, which was thought to be analogous to, but different in nature from, the electromagnetic field. The short range of these forces requires a modification of the field equations so that the static part of the field is now described by a modified 'Poisson' equation:

$$\nabla^2\varphi + \lambda^2\varphi = 0 \qquad (1)$$

with its singular solution, $\varphi = g\, e^{-\lambda r}/r$. The range of the forces is approximately $1/\lambda$. It is an *experimental* fact that $1/\lambda$ is of the same order of magnitude as the classical electron radius e^2/mc^2. g is a new universal constant with the dimensions of a charge. It determines the strength of the nuclear field. We derive its value below.

From (1) we can go over to a wave equation describing waves *in vacuo*:

$$\nabla^2\varphi - \frac{1}{c^2}\ddot{\varphi} + \lambda^2\varphi = 0. \qquad (2)$$

(2) can also be considered as a relativistic wave equation for a particle, but in contrast to the corresponding equation in Maxwell's theory, it describes the free motion of a particle with a *finite rest mass*, $\mu = \hbar/c\lambda$. Using the fact that $1/\lambda \doteqdot e^2/mc^2$ (m is electron mass), we obtain for the new mass the order of magnitude:

$$\frac{\mu}{m} \doteqdot \frac{\hbar c}{e^2} = 137 \qquad (3)$$

Moreover, it has long been concluded from the

saturation of the nuclear forces and other facts that the forces between a proton and neutron are connected with an *exchange of electric charge*. If this is taken literally, it must mean that the electric charge is not necessarily concentrated at the position of the proton but can also be found between the two particles. In other words, the nuclear field φ must itself carry electric charge. The free particles described by (2) are consequently *charged particles*, positive and negative, as will be seen below.

Three years after Yukawa had published these ideas, particles with these properties were discovered in cosmic radiation and named 'mesons'. The actual mass was found to be about $180m$, in good agreement with (3). Secondly, the cosmic ray mesons are charged (positive and negative). The agreement of these two facts with the prediction from purely nuclear considerations is so striking that there can be no doubt about the basic correctness of Yukawa's ideas.

Next we have to determine the value of the new universal constant g. For this purpose we use two more experimental facts: (i) The size a of the deuteron is little greater than the range of the forces $1/\lambda$. This is by no means trivial. The size of a hydrogen atom is the Bohr radius, whereas the range of the Coulomb forces is infinite. (ii) It is known that in the ground state of the deuteron the kinetic energy is almost equal to the potential energy, leaving only a small fraction of the potential energy for the binding energy. According to the uncertainty relation, the kinetic energy is

$$E_{kin.} \doteqdot \frac{\Delta p^2}{M} \doteqdot \frac{\hbar^2}{a^2 M} \doteqdot \frac{\hbar^2 \lambda^2}{M}.$$

The potential energy is approximately $E_{\text{pot.}} \doteqdot g^2\lambda$. Thus we find $g^2 \doteqdot \hbar^2\lambda/M$, or

$$\frac{\hbar c}{g^2} \doteqdot \frac{M}{\mu} \doteqdot 10. \qquad (4)$$

This gives a value for g of about 4 elementary charges e. The similarity of (4) and (3) is very striking. The two dimensionless universal constants $e^2/\hbar c$ and $g^2/\hbar c$ are both equal to the ratio of the masses of two elementary particles. Both relations are deduced from experimental facts, and so far we have no deeper insight into the meaning of these relations.

We have looked upon the field φ from two different aspects. On one hand, we have considered it as a field of force, and on the other hand, as a Schrödinger wave function for the meson as a particle. The two aspects are entirely equivalent. While the Maxwell field is primarily a field of force and can only be looked upon as a wave function for light quanta in special cases, and on the other hand the Schrödinger wave function of an electron never acts as a field of force, we can consider the meson field φ from whichever point of view is more convenient. Indeed, the production of the static field $ge^{-\lambda r}/r$ by a proton or neutron is often described in the particle picture as a "virtual emission and reabsorption" of a meson. This picture can often be used with advantage.

What is the precise meaning of this expression? We have already seen that the field φ carries an electric charge. If we would carry out an experiment to find the charge at a distance r, say, from the proton (or neutron), we shall, indeed, with a certain probability, find a charged particle at that point. (The charge can, of course, only appear in the form of a particle, that is, in an integral multiple of e.) The word emission in the above expression has thus a very literary meaning. On the other hand, such an emission of a particle with a rest mass μ would be contrary to the law of conservation of energy. While all other conservation laws (charge, momentum, angular momentum, spin, statistical) are fulfilled during this emission, the word 'virtual' means that, in contrast to a real emission, energy need not be conserved. If we therefore carry out an experiment to find the charge at a distance r from the proton, this experiment will only give a positive result if the necessary energy μc^2 is *supplied by the measuring process itself*.

This argument can be used to derive the extension of the nuclear field in a direct way without referring to a particular wave equation. The argument is due to Wick, but we give it here in a somewhat modified form. We measure the position of the meson at a distance r with an accuracy Δr of the order of magnitude of r itself. The particle will then have an average momentum $\Delta p = \hbar/r$. This is connected with an uncertainty of the energy

$$\Delta E \doteqdot \frac{\Delta p^2}{\mu} \text{ (if } \Delta p \text{ is not much larger than } \mu c).$$

ΔE is also the energy supplied by the measuring process. In order that the actual finding of the particle is not contradictory to the conservation of energy, ΔE must at least be equal to μc^2. Thus the experiment can only be successful if $\hbar^2/\mu r^2 \geq \mu c^2$ or

$$r \leq \hbar/\mu c. \qquad (5)$$

This expression gives the extension of the region in which the meson can be found, in other words, the extension of the nuclear field; and is identical with Yukawa's relation.

The next question is: How big is now the probability α of finding the meson outside at a distance r from the proton? Here the limitations of the theory become apparent. α depends, of course, on r, but it is clear that r must not be chosen too small. First of all, no meaning can be attached

to a dissociation where the meson is practically at the position of the proton, since this state is indistinguishable from the undissociated state. If r is smaller than $\hbar/Mc$, the measuring process supplies energies larger than Mc^2, and pairs of heavy particles can be created. The picture of a dissociated proton then fails completely. Even if we choose $r=\hbar/\mu c$, the concept of emission of a single meson fails, since then pairs of mesons can be created. To be on the safe side, we have therefore to restrict our concept to distances not much smaller than $1/\lambda$. But these are just the distances where the physical effects are of interest. Although for many problems the theory can actually be applied to much smaller distances, the simple concepts developed in this article break down in the very region in which they are of most interest. We cannot expect any quantitative results from them, but in the region of $\hbar/\mu c$ the results will be of qualitative significance.

To find the probability of dissociation, we calculate the total energy contained in the field outside $1/\lambda$ and divide it by the energy of the meson. It is safe to conclude from the analogy with the Maxwell field that the energy density is of the order of magnitude of $\text{grad}^2\varphi \doteqdot g^2\lambda^2$ at the distance $1/\lambda$. The volume of the region where the energy density has this value is of the order of magnitude of $1/\lambda^3$; thus the total energy is g^2/λ. The energy of the meson is $\sim \mu c^2$. The fraction of time spent in the dissociated state is therefore

$$\alpha = \frac{g^2}{\lambda\mu c^2} = \frac{g^2}{\hbar c} = \frac{1}{10}. \quad (6)$$

The nuclear particles have so far been considered as point- or mono-poles, being the sources for the field around them. Accordingly, the field was spherically symmetrical. There is, however, evidence that these are not the only sources of the meson field. It is known that the proton neutron force depends essentially upon the relative spin directions of these two particles. The difference between the singlet and triplet potentials of the deuteron is of the same order of magnitude as the potential itself. It must therefore be concluded that the spin of a heavy particle acts also as a source for a meson field, the latter being no longer spherically symmetrical but having a signified direction in the direction of the spin. The dependence on angle of this field is that of a wave function of a particle in a p-state. Thus we attribute to the spin of a proton or neutron a 'mesonic dipole' $\sigma f/\lambda$ (σ is the spin of the heavy particle), where f is another constant with the dimensions of a charge. At the distances of interest $(1/\lambda)$, this field has the same order of magnitude as the field of the mono-pole if the two constants g and f are of the same order of magnitude. This assumption can account for the spin dependence of the nuclear forces.

If we look upon the dipole field from the particle aspect, we can describe it in the following way: The proton is also capable of emitting virtually a meson with *angular momentum of one unit*, the angular momentum having the same direction as the spin of the proton before the dissociation. In order to satisfy the conservation of angular momentum, the spin direction of the heavy particle in the dissociated state must be the opposite one. The fraction of time spent in this kind of dissociation is also of the order of magnitude $\alpha = f^2/\hbar c \doteqdot g^2/\hbar c$.

Considerations of this kind lead to the qualitative explanation of another very important feature, namely, the anomalous magnetic moments of the proton and neutron. It is clear that a meson with angular momentum 1 has a magnetic moment larger by a factor M/μ than 1 Bohr nuclear magneton. This contributes to the magnetic moment of the proton an amount $\alpha\, M/\mu$ (in units of the nuclear magneton) which explains why the magnetic moments have such odd values. During the dissociation, the heavy particle is a neutron and has therefore no magnetic moment of its own. The heavy particle itself contributes therefore a magnetic moment $1-\alpha$. The total magnetic moment of the proton is therefore

$$m_P = 1 - \alpha + \alpha M/\mu. \quad (7)$$

Similarly, the magnetic moment of the neutron will be

$$m_N = -\alpha - \alpha M/\mu, \quad (8)$$

where regard has been taken of the fact that the neutron emits a negative meson with the opposite sign of magnetic moment, and that in the dissociated state the neutron has become a proton with opposite spin direction. (In (7) and (8) no account has been taken of the fact that a proton can dissociate into states where the meson has no angular momentum. It can easily be seen that this does not alter the result appreciably.)

Since both m_P and m_N are of the order of magnitude unity, we see that α must be of the order of magnitude of μ/M. But this is just the relation (4) derived from the binding energy and size of the deuteron, and gives further support for the assumption that this relation is not accidental. If we insert in (7) and (8) the observed values of $m_P = 2\cdot78$ and $m_N = -1\cdot93$, we have two equations for a new independent determination of α and M/μ. We find

$$\alpha = 0\cdot075 \quad \text{and} \quad M/\mu = 20,$$

in reasonable agreement with the values previously obtained for these universal constants.

The consistency of these results suggests that the

fundamental concepts of this theory are correct. We must not forget, however, that we have restricted our considerations to distances of the order of magnitude $1/\lambda$. Little can be said at present about the contributions of smaller distances. All we can say is that their contributions to the effects considered are at most of the same order of magnitude as those from greater distances. Our results are largely independent of the particular formalism chosen to describe the meson field, so long as it conforms with what we had to postulate. Many important details, however, do depend on the value chosen for the spin of the meson (0 or 1, or both); for example, the order of the levels in the deuteron, and the behaviour of the meson during collisions with other particles and light quanta. In some cases more or less serious difficulties arise if the theory is applied to distances smaller than $1/\lambda$. In this respect no definite decision has been reached yet, and we must expect further information from future developments.

Finally, we must also mention the β-decay of the meson. This was originally a second idea of Yukawa's, quite independent of his theory of the nucleus. It was assumed that the meson can decay directly into an electron and a neutrino. The decay of the meson has since been confrmed experimentally. The great advantage of this hypothesis is that it reduces the β-decay to a much simpler form. Whereas a nucleus decays emitting the electron into a continuous range of energy, the electron emitted by a free meson can only have the energy $\mu c^2/2$ (leaving the other half for the neutrino). The β-decay of a nucleus then takes place by means of an intermediate emission of a meson but the fundamental process underlying the β-decay of a nucleus is the decay of the meson. It is clear that a detailed study of the meson decay will give us very valuable information about the most important problem of the existence of the neutrino. A detailed discussion, however, lies outside the scope of this article.

BIOLOGICAL ACTION OF VITAMINS

By Dr. Elizabeth M. Koch

University of Chicago

SOME of the outstanding developments in vitamin research reported in the symposium on the "Biological Action of Vitamins", held at the University of Chicago as part of its fiftieth anniversary celebration during September 15–17, were:

(1) The further clarification of the functions of diphosphothiamin in carbohydrate metabolism by Mr. Severo Achoa, of Washington University, in St. Louis; (2) The separation of a new B vitamin, folic acid, a yeast growth stimulant announced by Mr. Roger J. Williams, of the University of Texas; (3) The proof of the identity of biotin, vitamin H, and co-enzyme R, presented by Mr. Vincent du Vigneaud of Cornell Medical College, New York City; (4) The isolation from egg white of avidin, a substance which combines with and thus inactivates biotin, also reported by Mr. Roger J. Williams; (5) The description of a new choline deficiency effect in young rats characterized by hæmorrhagic degeneration of the kidneys, described by Mr. Wendell H. Griffith, of St. Louis University, in St. Louis; (6) The description of the symptoms of human ariboflavinosis by Dr. W. H. Sebrell, of the United States Public Health Service; (7) The extension of vitamin therapy in human nutritional diseases, reported by Dr. Norman Joliffe, of New York University, by Dr. David L. Smith, of Duke University, and by Dr. Tom Spies, of the University of Cincinnati; (8) The use of vitamin K to prevent bleeding in patients having a low prothrombin content in the blood, reported by Drs. Harry P. Smith and Emory D. Warner, of the University of Iowa.

Mr. Achoa, in his discussion of the functions of diphosphothiamin, pointed out that through its effect on the oxidation of pyruvic acid, diphosphothiamin may be expected to influence various phases of carbohydrate metabolism. This is true because of the fact that pyruvate oxidation causes the storage of a considerable amount of energy in the form of adenosine triphosphate. We may expect diphosphothiamin to be indirectly involved in the synthesis of glycogen from glucose and in the conversion of fructose to glucose, since these reactions are driven by the mobilization of the phosphate bond energy in adenosine triphosphate.

Mr. Achoa also suggested the possibility that diphosphothiamin may aid in the absorption of sugar from the intestines and in resorbing glucose in the kidney tubules. It also may be involved in the process of forming carbohydrate molecules from lactic acid or from pyruvic acid. This vitamin complex likewise hastens production by the body of acetylcholine, an agent involved in the neuromuscular mechanism.

Folic acid, so named because it is most abundant

in leaves, was discovered as an important factor in yeast nutrition. Its isolation was accomplished this year by Mr. Roger J. Williams and his co-workers, who report its presence in all animal tissues examined, as well as in leaves. The implication that it is involved in animal nutrition is obvious, although nothing is known as yet of its function in the higher organisms.

Mr. Williams also discussed the various bio-assay methods, using yeasts and bacteria which have been developed by his group for the quantitative estimation of the eight water-soluble B vitamins discovered to date: thiamin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid, biotin, inositol and folic acid. These methods have proved highly satisfactory with respect to ease of manipulation and reproducibility of results.

Mr. Vincent du Vigneaud described the story of the steps by which three lines of research on vitamin H, the anti-egg-white injury factor, on biotin, one of the factors essential for yeast growth, and on co-enzyme R, which functions in the growth and respiration of many strains of legume nodule organisms—the Rhizobia—have converged to show that the three activities reside in one single substance.

In 1936 Kögl and Tönnis announced crystalline biotin. In 1939, West and Wilson suggested that biotin and co-enzyme R are probably identical. In 1940, György, Rose, Hofmann, Melville and du Vigneaud noted the similarity of the properties of vitamin H with those of co-enzyme R and biotin. They found that their vitamin H concentrates had parallel activity for the other two factors. A biotin methyl ester preparation contributed by Kögl had high vitamin H unitage. The du Vigneaud group then prepared biotin methyl ester from a vitamin H liver concentrate, and using this preparation confirmed the identity of biotin, co-enzyme R and vitamin H. Their product had a melting-point of 166°–167°, which is 18° higher than that reported by Kögl for his preparation. No explanation for this difference in melting-point has been found.

The structural formula of biotin has not been completely solved. It is probably a cyclic urea derivative with the composition $C_{10}H_{16}O_3N_2S$. By the action of barium hydroxide at 140° it forms a diaminocarboxylic acid, $C_9H_{18}O_3N_2S$. Biotin has been resynthesized from this diaminocarboxylic acid by treatment with phosgene.

Of interest in its relation to biotin was the reported isolation by Mr. R. J. Williams and his group of avidin from egg white. This is the substance which combines with and inactivates biotin, thus producing the so-called egg-white injury which develops when raw egg white is fed to rats and chicks.

The effect of choline deficiency on young rats was described by Mr. W. H. Griffith. Young rats on a low choline, low fat and low cholesterol diet exhibit an extremely toxic effect in which there is a marked hæmorrhagic enlargement and degeneration of the kidneys, a regression of the thymus and an enlargement of the spleen. The degeneration of the kidney particularly is very rapid, and may cause death in a ten-day period. The deficiency is prevented by amounts of choline too small to influence the deposition of liver fat. Supplements of cystine, fat or cholesterol increase the severity of the lesions; choline, menthionine and betaine neutralize their toxic effects. Since cystine, fat and cholesterol also increase the amount of fat in the livers of older rats, it appears that the hæmorrhagic degeneration and fatty livers are different manifestations of the same deficiency. The work of du Vigneaud and his co-workers proving that choline is involved in transfer of methyl groups indicates that the symptoms described are evidences of methyl deficiency. Griffith and his associates found that a creatine supplement lessens the severity of the lesions, but does not entirely prevent them. He suggested that while the methyl group of creatine is not available for choline synthesis, it may exercise a sparing action by making available for choline synthesis the methyl groups which would otherwise be used in the formation in the body of creatine.

As each vitamin has been made available in crystalline form, clinicians have studied its effect in the treatment of human subjects who present symptoms similar to those shown by animals that have been maintained on diets deficient in that specific vitamin. Dr. Joliffe discussed the use of thiamin for many types of polyneuritis frequently associated with alcoholism, pregnancy, gastro-intestinal disturbances and pellagra, as well as for cardiovascular disturbances, œdema, anorexia, and many other symptoms which may be manifestations of a sub-acute deficiency. He emphasized the importance of finding a means to detect early and mild vitamin deficiencies.

The history of pellagra and the final discovery that nicotinic acid is a specific for its cure long after this vitamin had been isolated, found ineffective in curing beriberi, and discarded as of no nutritional value, was related by Dr. David T. Smith. He described in detail the symptoms of nicotinic acid deficiency and the methods of treatment.

One of the most striking clinical developments in the vitamin field during the past two years has been the recognition of riboflavin deficiency symptoms. These were described by Dr. Sebrell. Dr. Sebrell and his co-workers placed eighteen adult women on a riboflavin-deficient diet. The first symptom

observed was a pallor of the mucosa in the angles of the lip. A few days later superficial fissures developed exactly in the angle of the mouth. These lesions were covered with a honey-coloured crust which could be scraped off without causing bleeding. The lips became abnormally red and shiny, and the tongue a purplish red. In addition, a fine scaly desquamation appeared about the nose and ears. The ocular lesions were equally marked. The cornea appeared inflamed, due to its invasion by capillaries. This condition was followed by corneal opacity. Patients complained of itching and burning of the eyes, a hyper-sensitivity to light, and eye fatigue.

These symptoms comprise the clinical picture known as ariboflavinosis. Dr. Sebrell has found it very prevalent among people who are not economically restricted to a poor diet. In fact, he stated, without the inclusion of liberal amounts of milk, liver and eggs, it is difficult to select a diet adequate in riboflavin.

In the case of human subjects, clinical experience has demonstrated that vitamin deficiencies are usually mixed, rather than simple, and that the administration of all the vitamins together produces more rapid and complete cures than does treatment with any single vitamin. This phase of vitamin therapy was emphasized by Dr. Tom Spies. He reported a study of "twenty-five malnourished patients with mild pellagra, beriberi or riboflavin deficiency who were becoming worse in spite of bed rest and were refusing the diet offered them. They were given a mixture of brewers' yeast powder (25 per cent), peanut butter (67 per cent) and peanut oil (8 per cent). All except two patients ate it twice a day, and all of them improved gradually." Because such a mixture is a rich source of the natural vitamins of the B complex, as well as of protein, fat, carbohydrate and mineral salts, he suggested the popularization of a sandwich of whole wheat or high vitamin bread, combined with this peanut butter – dried yeast spread as a most effective preventive or therapeutic measure.

The efficacy of vitamin K in preventing bleeding in patients with a low prothrombin concentration in the blood was reported by Drs. Harry Smith and Emory D. Warner. Hæmorrhages due to failure of the blood to clot occur in both mother and child at child-birth, in obstructive jaundice, in chronic intestinal disorders and in bile duct tumours. This failure to clot is due to the inability of the body to produce enough prothrombin. Vitamin K is an essential factor in the production of prothrombin. It is effective administered orally.

Drs. Smith and Warner recommended the inclusion of green vegetables, especially spinach, kale and tomatoes, in the diets of mothers during the last month of pregnancy, and the feeding of cow's milk to infants during the first three days of life to provide the necessary vitamin K during this critical period.

The most recently separated vitamins, pyridoxin and pantothenic acid, are already being studied clinically. Although a pyridoxin deficiency has not been described as a definite entity, the vitamin is believed to function in muscle metabolism. It was reported to cause improvement in patients having muscular weakness or suffering from Parkinson's disease. Here, again, administration with or after thiamin and nicotinic acid produces better results than when pyridoxin is given alone.

Pantothenic acid has been found in human blood. Dr. Edgar S. Gordon, of the University of Wisconsin, stated that very little is known as yet of its possible functions or of its clinical value. Spies and his co-workers found that the injection of pantothenic acid was followed by a rise in the riboflavin content of the blood. He believes that this vitamin is also essential in human nutrition, and that it is associated in its action with riboflavin.

LABOUR CONDITIONS IN WEST AFRICA

By F. W. H. Migeod

FOR countless centuries Africa had supplied labour to Eastern countries. When the American continent was discovered, an immediate demand arose for African labour for its plantations and industries. Eventually the slave trade came to an end, and Africa turned to developing the export of its own products, chiefly forestal. Progress after the change-over was slow at first. At the opening of the present century, however, mining was already well established, and plantations were started to extend the growth of economic products and secure a higher standard of quality. There ensued an increasing demand for paid labour. Nevertheless, in West Africa, the collection and preparation of forest products was still carried on by the natives in their own villages, as it still is. They traded their loads at the nearest store, or the one that offered best terms, and what they received for it was shared out between the members of the family concerned.

Labour in tropical Africa implies rather a different thing from what is understood by 'labour' in Great Britain at the present day. The native tribal organization has usually consisted of a ruling class with the rest of the population slaves, or at least dependants. Merging with the ruling class was general; and another stratum of slave population might be added below as the result of a successful war. Agriculture, the principal industry, was therefore based on slavery. On slave labour the tribe supported itself, and had a small balance of material or, in default, human goods to export. Some tribes kept no slaves; they were cannibals. Some remote hill tribes or swamp tribes may also be exceptions.

When, therefore, the European colonies or protectorates became established, the Government readily obtained the labour it required by calling on the chiefs to furnish so many men for some definite work such as building stations, making roads, railway construction, etc. The labourers would be paid if the work were beyond the chief's confines; within his own country he was responsible for it, and a money gift would usually be made to him in compensation. The Government was only concerned with the labour supplied being kept up to the number specified. Welfare conditions scarcely entered in. The labour largely looked after itself. As a result, however, of the opening up of the country to private enterprise, apart from trading, new conditions had to be met.

This is the background which it is useful to bear in mind when reading the able and valuable report by Major G. St. J. Orde Browne, labour adviser to the Secretary of State for the Colonies, presented to Parliament in May of this year*. Each of the West African Colonies, Nigeria (with British Cameroons), Gold Coast, Sierra Leone and Gambia is studied separately, and roughly the first quarter of the pamphlet contains a summary of observations and recommendations. Major Orde Browne has had long labour experience in East Africa, and in his five months in West Africa in the dry season of 1939–40 he was able by means of extensive and rapid travel to probe into labour conditions in all these colonies.

The welfare of the labourer was his first consideration. The number of instances in which he could find nothing to recommend is testimony to the generally satisfactory labour position of West Africa. It is mostly in the big Europeanized towns where improvements are called for.

It has already been said that labour questions in Africa, and more particularly in West Africa, cannot be treated in the same way as in Great Britain. The great majority of the natives are attached to the soil. This means that everyone has a home to return to whether he be of free or servile origin. He can come out periodically to work for hire, and when he has earned what he considers enough to go back home with, he departs and resumes his agricultural life. He is free so far as his wage-earning is concerned to take it up or not, just as he pleases. Where this general statement does not apply is in the large towns, where a mixed population has collected which has lost touch with home life, and either cannot, on account of distance, or for some other reason does not desire to, return to the place of their birth. Perhaps it is because he is a seasonal worker that he does not like being interfered with even for his own good, a fact Major Orde Browne refers to more than once. He has come to gain money, and will put up with inconveniences to do so. The local abundance of food is a major factor in the choice of his place of work. Often food weighs more in this choice than the actual wages paid.

This report discusses food problems very fully. The view has grown up in recent years in Great Britain that the African is generally undernourished. He used not to be. If undernourishment does exist at all widely, it is a result of economic development of the country, food-growing being subordinated to the production of sale crops or of mechanized industry. Without going deeper into the matter, it may be observed that large markets, such as are especially common in Nigeria, go a long way towards stimulating the growth and equally important distribution of food.

The migratory type of labour, that is the seasonal workers, have in some cases long distances to travel. Usually, however, they know exactly where they intend or hope to work, and travel in parties, some members of which have been over the ground before. There are, of course, cases in which some of the party fall out by the way, and one rather gets the impression from this report of large numbers of would-be labourers arriving at their journey's end worn out with the march and suffering from exhaustion from want of food. Such cases may occur. In any event, rest camps set up by the Government on the main routes are a great boon to the travellers. The mere walk of a few hundred miles is nothing very serious of itself. One has done it oneself. They are not entirely without ideas of food-provision for the journey; and food will be supplemented with saleable goods. In many cases the women go too.

Housing is a subject the migratory labourer is not too greatly concerned with. So long as he has somewhere to spread his mat, and the householder will look after his few personal belongings, he is satisfied. Except when actually asleep the house

* Labour Conditions in West Africa. Report by Major G. St. J. Orde Browne. (Cmd. 6277.) Pp. 149. (London: H.M. Stationery Office, 1941.) 2s. 6d. net.

is scarcely wanted. He especially does not like a draught, having few clothes on indoors; and so concrete houses with tin roofs do not meet with his approval. The hygienic house is not necessarily the most comfortable. However, judging by this report, living conditions in general are good on all the old-established plantations, and are equally so on the mines. Where overcrowding and bad living conditions do apply is in the towns or in the villages surrounding an industrial area; and it is with this very difficult problem that the Medical and Sanitary Department has to cope. Here, too, police problems are equally acute.

All the difficulties, however, in connexion with the labourers who come and do eventually go home, are small compared with the problems of those who do not go, either from illness or some other cause. Only too many of them unable to do regular work turn to crime. They spend their money as they receive it, and when that has become an acquired habit they will in fact never return home. There are many such. They form the body of floating labour, and it is mainly on their account that such reports as Major Orde Browne's are written.

Skilled labour figures equally largely in this report. Such labour is a product of education in some form or other. That may be either apprenticeship in the workshop, or a course of training in Government technical schools. Both systems have their values, and it is debatable whether the youth who has, say, had his training in railway workshops with a certain amount of rough-and-ready treatment, is not better equipped than one who has led a very different life in a residential college, with amenities that render him less willing to undertake any sort of work. Urbanization is, of course, a necessary preliminary to the raising of a large body of skilled artisans, and those persons necessarily become detribalized and merge into the permanent population of the large towns. The report stresses the need for more and still more technical training; and the future of the colonies would seem to lie in a good supply of all sorts of technicians being turned out.

The early trend of education was the production of clerks. Every bright youth at school wanted, and still wants, to become a clerk and wear good European clothes and not do manual work. So associated is manual labour with inferiority of social status (and not in Africa alone), and indeed with old slavery memories, that no native considered he had improved his position unless he adopted the clerical or teaching or some similar profession.

All efforts of the Government to restrict the output of persons trained as clerks have been very largely neutralized by this ambition. When clerkships are, even in their lower grades, better paid than skilled mechanics in their higher grades, and really large salaries can still further be obtained either in the Government service or in trade or the professions, it is not surprising that the youth of the country desires training for the most lucrative work; and their parents share these views. Girls qualify to be telephone operators, shop assistants, etc., but only to a small extent, as the vast body of African opinion still considers the place of the woman is in the home.

For the welfare of labour, Major Orde Browne makes many valuable suggestions, as would only be expected from a man of his experience and qualifications. There is one qualification, however, which one is not sure that he has. One doubts if Major Orde Browne has ever handled labour personally; whether he has ever had to get his labour together for some enterprise, to work it to the utmost, and yet keep it and maintain his employment at such a level of attractiveness that he is never short; also whether he has personally experienced all those repetitions of exasperation and anxiety that success in keeping his own end up implies. The trend of colonial legislation has been to reduce penalties on delinquent labour and increase them for employers; but Major Orde Browne does point out that the latter have in cases been overdone. Unless there are would-be employers with capital entering a colony, there can be no wage-earning; and because a labourer has innocence on his face it does not follow there is innocence in his heart. Trade unionism has been imposed on the colonies from Great Britain. It applies less to the seasonal worker than to the urbanized population. Since, however, in all towns natives of different tribes normally congregate together, and have a titular chief of their own tribe to watch over their interests, the necessity for trade unionism, if any exist, is limited to detribalized natives. In some pages of this report it seems as if there are two persons speaking. One is Major Orde Browne, the experienced African official; the other is someone else who has adapted himself to trade unionism and British labour ideals.

Of the numerous recommendations made, many are expensive. The report was made on conditions prevailing in the earlier period of the War. With the subsequent cessation or limitation of external trade in West Africa, it may be doubted if any more than a small proportion of the recommendations can be put into force. Indeed the necessity for many of them may have lapsed. The best thing the native can do now would seem to be to revert to his former life on his farm and, growing enough food for his family, await a time when industrial and trading activities can be profitable.

NEWS AND VIEWS

Royal Society Personal Records

THE portion of Sir Henry Dale's presidential address to the Royal Society delivered on December 1 which was of wider appeal is printed on pp. 678–80. Another section of the address, at the moment mainly of domestic interest to the fellows, dealt with a scheme which Sir Henry, with the Council's approval, has just introduced, for compiling a contemporary record of the fellows and their activities. The object is to provide the Royal Society with a complete set of personal records of all the fellows from now onwards, with annual additions to keep them up to date. So far as the more senior of the fellows are concerned, many of them, as Sir Henry pointed out, can look back over a period in which the change and expansion of scientific knowledge have been so rapid and so revolutionary that their memories of those days must be of vital interest for the history of science. The biographies of outstanding men of science provide valuable material in the form of impressions and memories of their previous generation, but such sources are relatively few in number. Sir Henry referred in particular to men like Sir J. J. Thomson and Sir Oliver Lodge, whose activities brought them into contact with many outstanding figures, and mentioned the interest—and indeed the value for posterity—of contemporary accounts which might well have been kept by fellows of the Society of their association and discussions with such outstanding figures as Claude Bernard, Louis Pasteur, Robert Koch, Carl Ludwig and others of the latter half of the nineteenth century. The proposed personal record of fellows of the Royal Society will, in Sir Henry's words, "provide a fair picture of the main currents, at least, of scientific progress in this country", which will be invaluable to the future historian who may be called upon to show the general character of this scientific age.

Martyrdom of Polish Men of Science

ON November 26 a meeting unparalleled in the history of science was held at the Royal Institution, where, in the presence of the Presidents of Poland and Czechoslovakia and General Petit (representing General de Gaulle), representatives of scientific institutions and associations from Great Britain and men of science and letters of many nations met to pay homage to the memory of the Polish professors and lecturers who had died as the result of German barbarism, and to register their protest against this crime on science and culture. Sir David Ross, vice-chancellor of the University of Oxford, who presided over the meeting, stated that the Germans are endeavouring to convert Poland into a vassal country by depriving her of her leaders, and that their brutalities fall mostly on academic life. November, 1941, is the second anniversary of the beginning of their many atrocities against science and learning, when the whole of the professorial and lecturing staff of the Jagellonian University in Cracow, the oldest in eastern Europe, was arrested and imprisoned for no other crime than that of being Poles. He described their tortures and humiliations and concluded by saying that the action of the Germans has had the opposite effect to that desired, and the suffering professors have become a symbol of martyred Poland. Dr. Gilbert Murray said that when war breaks out the first casualty is truth, but never has the lie been organized as it now is in Germany.

Prof. Antoni Jurasz, dean of the Polish Medical School in Edinburgh, spoke with an eloquence and fire which in itself was symbolic of the unconquerable spirit of his country. He described the crushing of academic life in Poland, the suppression of all learning, the pillaging of the Universities of Cracow, Warsaw, Lublin, Lwow and Vilno and the destruction of libraries and manuscripts. He spoke of many of those who have met their death, names as well known in other parts of the world as in their own country: professors of philosophy, anatomy, physiology, mechanics, literature, zoology, engineering, biology, physics, chemistry, and many others. The international character of the present meeting testified that all are united to fight the forces of darkness and that on the graves of these fine men and on the ruins of their work will be built up a new world. Prof. René Cassin, member of the "Université de France", who spoke on behalf of the Free French and also on behalf of all Frenchmen who have been reduced to silence by the invader, expressed his horror of the crimes perpetrated on intellectuals in Poland, mentioning the death of students in France who have protested against the aggressor. M. Juraj Slavik, Minister of the Interior, and Prof. Klecanda spoke on behalf of Czechoslovakia and stressed the close association between Poland and their country. Prof. Stefan Glaser, chairman, replied on behalf of the Association of Polish University Professors and Lecturers in Great Britain.

British Chemists and the U.S.S.R.

THE Chemical Society has recently sent the following message of greeting to the All Soviet Union Chemical Society. "We, the President, Council and Fellows of the Chemical Society, send greetings to you, our Colleagues in the All Soviet Union Chemical Society. We express our unbounded admiration for your Country's courage and heroic fight against the power and might of the common foe, and our deep sympathy in the suffering and cruelties inflicted on your people by the invader. Our two Countries stand together in this struggle, and we are confident that, with the united efforts of all those who realise the abyss to which Hitlerism is leading, tyranny will be overthrown and peace and justice prevail. It is our earnest hope that out of this strife and sacrifice will emerge a new order in which the prostitution of Science to the destruction of mankind will cease and men and women engaged throughout the World in the pursuit of Science will work together in amity for the benefit of the human race."

Biology and Health

At the twenty-sixth annual general meeting of the British Social Hygiene Council, the president, Sir Walter Langdon-Brown, took for his subject the relation between biology and health. This address has been printed in the current issue of the organ of the above Society, *Health and Empire*. As an introduction he described the attempts that have been made by certain countries to degrade all the standards of learning and to stultify the search for scientific truth. Quoting from this year's report of the Rockefeller Foundation, Sir Walter explained how, all over Europe, the activities of the Rockefeller Foundation have been brought to a standstill. "The conception of knowledge as an international responsibility has vanished . . . as German forces have moved from one country into another a definite pattern has been followed." Where this was resisted, faculties were sent to concentration camps and student demonstrations were broken up with machine-guns and tanks. The rest of this story is too familiar to need reiteration. In 1932, *Pflugers Archivs*, the outstanding publication for seventy years in physiological and biological research, ran to five volumes. In 1938 it appeared as one slim volume. The *Münchener Medizinische Wochenschrift*, formerly one of the leading weekly medical journals in the world, has now become the happy hunting ground of cranks and naturopaths who hope to catch the Führer's eye. Yet the lamp of learning will never be extinguished, and Sir Walter went on to deal with particular examples of the way in which biology has made for improved conditions of health. The well-known work of the Rockefeller Foundation in controlling the spread of *Anopheles gambiæ* after its introduction to Brazil from Africa in 1930, and its almost complete —if not complete—eradication by 1940 was one of the more important examples that were considered.

Later, Sir Walter described the steps that will have to be taken to combat the ravages of venereal diseases. Although the causal organisms of these diseases have been known for many years, there is still in existence the 'hush-hush' policy which refuses to admit the cleansing light of understanding. The traditional opposition of the Victorians to any mention of sex matters in polite circles initiated a conspiracy of silence which is long a-dying. But this silence is being confronted by freer and franker discussion of sex matters among all classes. In this connexion the introduction of biological subjects with its objective approach to the study of reproductive physiology, in many schools and colleges, has played a noticeable part. The three main planks in the platform of the British Social Hygiene Council were outlined as follows: (1) The study of biology as a subject of general education; (2) the education of the educator; (3) general enlightenment on the principles of social hygiene. The remainder of the address was devoted to an amplification of these three problems and an account of the manner in which the British Social Hygiene Council is trying to grapple with them. A most heartening feature of the address was the statement that there has been no sensational rise in the incidence of venereal diseases in this War as there was in the last.

The University of Liverpool

The annual meeting of the Court of the University of Liverpool was held on November 27, the Chancellor (the Earl of Derby) presiding. Lord Derby paid a high tribute to the work of the University throughout a difficult year in which the University buildings suffered considerably by enemy action. He recorded with pleasure, however, that the loss of life was fortunately slight, and that despite all difficulties, study has been maintained on a high standard. Sixty-five members of the teaching staff are now serving with the Forces or in Government Departments; the Senior Training Corps is strong; and the Air Squadron has grown considerably. The work of the Women's Training Corps has prospered, and the basic training in social service is well advanced. Thanks to the generosity and friendship of the City Council, the University is now receiving an annual grant which has reached the total of £25,000. By the generosity of Messrs. J. Bibby and Sons, the University has now been able to establish in Wirral a Veterinary Field Station under Prof. J. G. Wright.

The coming retirement of Prof. E. W. Marchant from the chair of electrical engineering was announced at the meeting. Mr. R. H. Armstrong, pro-chancellor, detailed the progress of the regionalization of the voluntary municipal hospitals, in which the University should become a focal point. He paid tribute to the research work of the University, affirming that through it, the national effort has received and would continue to receive a handsome dividend. His analysis of income and expenditure showed that the University finances are sound and that war conditions have imposed no undue burden upon student finances. The vice-chancellor (Dr. A. D. McNair) submitted his annual report, in which he emphasized the expansion of the Senior Training Corps and the part played by women students in national service. All women students were now required to engage in part-time national service.

British Standards Institution

The British Standards Institution announces that, in view of the continuing expansion of the work of the Institution and the development of its relations with the Government Departments and with standardizing authorities overseas, the General Council has appointed an Executive Committee under a permanent chairman. The Executive Committee will keep all the activities of the Institution under review and report to the General Council from time to time as may be necessary. Mr. C. le Maistre, who has been connected with the movement almost since its initiation, and who for the past twenty-five years has been its chief executive officer, has been appointed full-time chairman of the Executive Committee, and Mr. P. Good, for several years deputy director and recently joint-director, has been appointed director and secretary of the Institution.

Bracken-infested Land for Potato Cultivation

BRACKEN-INFESTED land can be made very suitable to potato growing provided the proper methods of cultivation are used. Such land is normally light and would be easy to work if it were not for the formidable amount of roots and surface trash that must first be cleared. Trials (described by I. F. Trant, *J. Min. Agric.*, 48, 109; 1941) have been carried out on three areas near Welshpool to determine the best methods for preparing this type of land for a potato crop, and much valuable information has been obtained. Autumn ploughing followed by spring cultivation and immediate planting proved to be expensive and unsatisfactory, as the bracken roots prevented the proper working of the land. Gyro-tilling in the spring after the ground had been 'pre-disked' killed off the bracken quite well, but it also was expensive and did not succeed in clearing the trash. A third method, however, though slower than the other two, gave most promising results and at considerably reduced cost. In this case the bracken was ploughed during June and July when it had attained its maximum growth and its reserve of food in the underground portions was at a minimum, a special device for burying the tall fronds being employed. The land was then worked and sown to rape, which was fed off to sheep during the autumn, thereby consolidating and manuring the ground. In the following spring, disk harrows and cultivators produced an excellent tilth, ploughing being omitted as it was likely to bring to the surface rubbish that was best left buried. Potato planting could then be satisfactorily carried out.

Electric Railways in the U.S.S.R.

IN the second of a series on "Transport in the Soviet Union", *Modern Transport* reviews the progress of railway electrification in Russia. It is stated that there were no electric railways in Imperial Russia. The Soviet began the electrification of the suburban lines in the Baku area in 1926 on the D.C. system at 1,200 v. with overhead conductors. In 1929, the 1,500 v. D.C. system was adopted with the inauguration of electric working in the Moscow suburban area, where up to 1926 electric traction was introduced on 112 route miles. In the Leningrad district, 44 miles of route underwent conversion during 1933–34. According to the *Electrical Review* of October 31, on these and certain other local lines in the Caucasus multiple unit passenger trains are employed. In 1932 a start was made with the electrification of certain main lines in mountainous and industrial areas, using the 3,000 v. D.C. system with heavy locomotives of three principal types for passenger, mixed traffic and freight trains. By 1939, electrified main lines comprised 828 route miles with an all-track mileage of 1,100 situated in the Caucasus, Ural, Donbass and Kussbass areas, and also on certain sections of the Murmansk line. Quite apart from the electrified suburban system in Moscow is the underground railway known as the Metro, which ranks not only as one of the newest, but also as one of the most lavishly carried out schemes of city transport in the world. It was authorized in 1931, and work began in 1932. By 1937 the Metro had 16·45 miles of route, and expansion was continuing.

Recent Earthquakes

ON the evening of November 25 an earthquake caused some apprehension in Lisbon and the surrounding country, though little material damage appears to have been done. Details of recordings from seismographic observatories are awaited before the exact epicentre can be determined. Several of these observatories report very large amplitudes. Fordham University (New York) reports the largest amplitudes since 1910; at Mr. J. J. Shaw's observatory at West Bromwich the recording levers were thrown out of their sockets; at Stonyhurst College Observatory the limits of registration exceeded the width of the paper; the shock was recorded at Kew and Oxford, though, according to Miss E. F. Bellamy, the amplitudes were not so great at the latter place.

On November 28 an earthquake of considerable severity was reported from Peshawar, Rawalpindi and Srinagar. No damage or casualties have been reported. Earthquakes in this district have not been uncommon in recent years and have been regularly reported by voluntary observers to J. M. Sil, representing the India Meteorological Department at Poona.

Announcements

AT the suggestion of Dr. G. Jedlewski, medical adviser to the Polish President, a special medical board has been formed in London to prepare plans for fighting epidemics which may break out in Poland at the end of the War.

A DIETETIC council has been set up in Ireland with Dr. P. T. O'Farrell to experiment on ways and means of aiding the people's nutrition under war-time conditions, paying special attention to the children's diet.

WE regret to announce the following deaths:

Dr. H. Eltringham, F.R.S., the well-known entomologist, president of the Royal Entomological Society during 1931–32, on November 26, aged sixty-eight.

Dr. Walcot Gibson, F.R.S., formerly director for Scotland, H.M. Geological Survey of Great Britain, on November 28, aged seventy-seven.

Dr. F. Stang, rector of the University of Oslo during 1921–27, president of the Nobel Committee of the Storting, who did much pioneer work in comparative research in human culture, aged seventy-four.

ERRATA. "Rigidity and Moisture Hysteresis in Gels", by W. W. Barkas, NATURE, November 22, p. 629. The following corrections should have been made in the MS.: (*a*) in equation (1), the upper limits of the integrals should read p and h_0 respectively; (*b*) in equation (2), the upper limits should read p_{k_0}, p_{n_0} and h_0 respectively; (*c*) seven lines below equation (1), for V read v.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Colour Measurement

As was recently noted in NATURE[1], an increasingly high degree of accuracy in the specification of colour in terms of C.I.E. units is now being sought as a result of the growing realization of the indefiniteness of the colour discrimination limen and the low values it can assume in quite ordinary conditions. One would normally regard such circumstances as indicating in any physical quantity to be measured an ultimate need for correspondingly higher absolute accuracy, but it should not be overlooked in this case that higher discrimination is really called for in a quantity different from the one already standardized for use in colorimetry. The latter quantity, which is defined by the C.I.E. (1931) resolutions and data and will be denoted generally below by $\chi_{\text{C.I.E.}}$, refers to (*a*) a normal observer and (*b*) normal observing conditions, including particularly (*c*) a field of direct observation of 2° to which observations were necessarily intended to be restricted in order that they should apply to a region of uniform retinal structure and thereby have analytical significance.

The present position in colorimetry is due mainly to a growing recognition of the practical effect of varying sub-condition (*c*) by increasing the field size, which results in increasingly higher powers of colour discrimination. If we imagine the so-increased retinal field to be subdivided into smaller fields, we may reasonably assume that the same *form* of colorimetric analysis would apply for each, but the exact analysis for each and the method of reconstituting without loss the 'colour' as perceived, in a synthesized physical expression of it, remain subjects for future investigation. Certain it is, however, that this reconstituted colour would provide us with a new physical concept determined by a new quantity, χ_N say.

It is in the magnitude of this quantity that the higher precision is now really required. The individual quantities from which χ_N would be synthesized, considered in terms of any acceptable common units, might, of course, differ appreciably from one another in a yet unknown way, so that the problem of exact specification of colour as such, under the new varying sets of conditions, and to the higher accuracy called for, still awaits a final solution, which prevailing circumstances may postpone. If to some the need is urgent, one may—although without much justification—adopt as an expedient a procedure which, in fact, represents present practice, namely, identify conventionally, but nevertheless falsely, the colour magnitude $\chi_{\text{C.I.E.}}$ with χ_N, and ask of $\chi_{\text{C.I.E.}}$ the accuracy actually desired in χ_N.

True it is that, providing suitable standards exist and ageing effects therein can be controlled to the necessary accuracy, the light, the colour of which may be in question, might be spectrophotometered to an accuracy corresponding in itself to the accuracy of colour discrimination sought; but as will be clear from the foregoing, this does not satisfy the conditions of the problem except as an expedient. Some further important questions have, moreover, to be considered in this connexion, and it will be seen that, to the accuracy here in question, this procedure is only ultimately valid as a method of relative differentiation of colour magnitudes. For, first, we must notice that the C.I.E. data serving to define $\chi_{\text{C.I.E.}}$ were obtained from observations made upon a 2° field. It is, therefore, no criticism of these data to say that, considered in relation to the higher accuracy now being sought, residual errors of importance may be present therein. The reduction and tabulation of the original observations as so obtained cannot therefore be regarded as affording data of ultimate accuracy. Consequently, abnormal accuracy is not *a priori* justified at present in determinations of $\chi_{\text{C.I.E.}}$ as such. What signification can we attach to a quantity so perverted from its true nature as is $\chi_{\text{C.I.E.}}$ as currently adapted to new conditions in the above way? Clearly the actual sense in which it can be employed is not the truly physical sense originally intended as applying to the accepted normal observer but only an unreal and purely conventional one. It should therefore be recognized that, however this use of the adapted $\chi_{\text{C.I.E.}}$ may be justified as a practical device, a new term, $\chi'_{\text{C.I.E.}}$ say, differing from the original $\chi_{\text{C.I.E.}}$, has in fact been introduced by the simple act of adaptation, and has been employed in practice.

Secondly, we must notice that increased accuracy as such is not really directly called for, the specific need being for higher precision, not accuracy, of individual colour measurements in order to ensure the accuracy of differences in given circumstances. Standardization could not, of course, be ultimately dispensed with, but the immediate problem is clearly one of differential colorimetry, which is technically different from that of absolute colorimetry. Given a suitable standard, for use with a differential colorimeter, known in colour to an absolute accuracy within the degree of differential accuracy, δ_1, yielded by that instrument; then measurements, in absolute terms, of $\chi'_{\text{C.I.E.}}$ could be determined to any requisite accuracy limited only by δ_1. But if such a standard is not immediately forthcoming, the measurement merely of differences of $\chi'_{\text{C.I.E.}}$ to the same accuracy would still materially assist the colorist, and, if the effects of ageing could be controlled, possibly provide him, at least in some cases, with all he needs in this respect; for his interest in the absolute measurement of colour would then enter wholly or mainly through a consideration of colour differences which generally are so large as to render practically insignificant the small differences which are important in a differential sense.

Thus the present position is not entirely dependent upon the resolution of the outstanding problems of the ultimate standardization of colour. These present an important field for physical research, and incidentally provide material for an inquiry on philosophic method. The analytical nature of physical explanation imposes upon investigation formal conditions of method which, in the present case of colour, by securing accuracy of form have lost to us the essential precision in the substance of our observations.

Although this may be inevitable in the case of a directly estimated quantity of the type here in question[2], it has the form and effect of a paradox, the influence of which upon the progress of colorimetry as a branch of physical science it will be an important problem to remove, if the underlying nature of colour is to be made clear and if colour as a physical concept is to preserve and maintain its true and proper signification in the fullest possible sense.

It may be mentioned that these considerations are not put forward with the object of indicating academic propositions without effect upon the practical development of the subject. They affect directly its practical development in a fundamental sense, and arise in a manner unusual in physical investigation merely because of the unusual types of quantities and magnitudes with which we have at present to deal in the physical investigation of colour.

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[1] NATURE, 148, 506 (1941).
[2] *Proc. Phys. Soc.*, 53, 275 (1941).

Philosophy of Physical Science

THE recent discussion between Sir James Jeans and Sir Arthur Eddington [see NATURE of Oct. 25, p. 503 and earlier references], in so far as it involves the Fitzgerald-Lorentz contraction, prompts me to direct attention to an aspect of this matter which I presented recently before the American Physical Society Symposium on Philosophy and Science[1].

For many years I have maintained that the Michelson-Morley experiment has rather an illusory significance in relation to the theory of relativity and is, in fact, not fundamental to it[2]. There are, in fact, two aspects to the meaning of invariance under the Lorentzian transformation. The first, A, is a pure mathematical one and is concerned with the fact that if the equations are transformed from one set of variables to another by a Lorentzian transformation, they revert to the same form. The test of this is a pen and paper affair. The second aspect, B, implies all that is contained in the first and, in addition, the postulate that the second set of variables is that which an observer, moving with velocity v in relation to the origin of co-ordinates of the first system, would automatically use.

Suppose that in a system S I have a rod to which I impart a velocity v. In this process, all sorts of acoustical vibrations are set up. These die down in time, but how does the rod decide that it must settle down to a new length determined by the Fitzgerald-Lorentz contraction? The acoustical vibrations cannot be dismissed lightly, since they are part and parcel of the whole mechanism by which the rod received its motion. It seems that the quantum theory, if relativistically invariant in form, possesses the power to give the necessary answer.

According to the quantum theory, the form and stability of the rod at rest in S are determined by its being in a 'ground state'. Now if the equations are invariant in the sense A, we know that if we have, in S, one solution for, let us say, the Ψ function, satisfying the usual conditions of continuity, etc.; then associated with this solution we have an infinite number of other solutions obtainable from it by a Lorentzian transformation, and *these are all possible quantum states in the systems*. (It is quite true that on the aspect B any one of them would also be a quantum state in a system S' of measurements moving in relation to S with velocity v. I wish to make no use of this fact, however.) Any one of these states presents, of course, as one of its aspects, the picture of the rod moving along with a velocity which, measured in S, is equal to the value of v which occurs in the transformation, and the state can, therefore, by the quantum theory, be a possible state for such a rod. The ground state for the rod moving with velocity v is the state obtainable by a Lorentzian transformation from the ground state of the rod before the motion was imparted. It is, therefore, the state which the moving rod may be expected to assume unless the perturbation forces involved in the production of the motion are so large as to have produced the kind of quantum transitions of finite and, in general, large magnitudes which are associated with what we may call non-reversible changes in structure. In general, we may say that the kind of forces which are associated with the determination of structure are those characteristic of molecular affinity, and the quantum transitions necessary to produce non-reversible changes in structure are such quantum transitions as would be involved in molecular quantum transitions.

It thus appears that a relativistically invariant quantum theory, or something closely analogous to it, is a necessary supplement to the general principle of invariance of equations if we are to provide for the Fitzgerald-Lorentz contraction and for the customarily accepted form of the theory of relativity symbolized by what we have called the form B.

W. F. G. SWANN.

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Sept. 23.

[1] Held at Providence, R.I., June 21, 1941. The address and a special amplifying paper concerning the specific point in question are published in *Rev. Mod. Phys.*, 13, 190 and 197 (1941).
[2] Swann, W. F. G., *Phys. Rev.*, 35, 336 (1930); *Rev. Mod. Phys.*, 2, 243 (1930).

I HAVE terminated my correspondence on the philosophical controversy; but since Dr. Swann's letter deals with a purely scientific question regarding the relations of relativity theory and quantum theory, I venture to offer some remarks.

As Swann points out, the Lorentz transformation is no more than a mathematical change of variables unless it is coupled with a theory of the 'similarity' of the fixed and moving systems. I would remark, however, that the problem of similarity arises in physics at a much earlier stage, namely in defining a standard of length. Swann's question, how a rod decides its extension when it is given a different motion, is only part of the general question how it decides its extension when it is given a different location in space and time. Surely the answer is given by the law of gravitation, which definitely expresses the fact that the rod decides its extension by measuring itself against the local space-time curvature—that being the only linear characteristic available for comparison[1].

Dr. Swann's conclusions are reached in a general form if we adopt a more elementary starting-point. When we make statements about lengths in a remote star or at a remote epoch, it is implied that there

and then a physical standard (with the desired orientation and velocity) could be constructed 'similar' to a corresponding terrestrial standard; and the statements have no meaning unless we define the criterion of similarity. This is discussed rather fully in "The Philosophy of Physical Science" (pp. 73–85). It is concluded that the two standards must be constructed from a common specification; and the quantitative part of the specification must consist of *pure numbers* only, since it is required to precede the definition of length and all other physical quantities. This means that the specification must be a quantum specification; because it is only in quantum theory that a method has been developed of describing material structure by pure numbers—numbers of elementary particles the mutual arrangement of which is specified by quantum numbers. Thus appeal must be made to quantum theory for the definition of the interval ds, which is the starting-point of relativity theory.

Naturally the quantum theory must harmonize with relativity theory, and Dr. Swann is no doubt technically correct in saying that it must be relativistically invariant in form. But, as I have recently pointed out[2], this condition has been widely misunderstood and misapplied in quantum theory. It is often understood to mean that the equations should be Lorentz-invariant in form. But Lorentz invariance (or, more strictly, covariance) is no more than a special formula applicable when two systems, though considered in conjunction, are physically isolated—a condition rarely, if ever, arising in quantum problems. There is no more value in employing Lorentz-covariant equations in treating the internal structure of an atom or nucleus than in treating the internal structure of a star. 'Structural equations' are relativistically invariant as they stand, since they remain true whatever the motion of the body possessing the structure.

To come back to the original problem, if we suppose the fixed and moving rods to be calibrated by reference to the dimensions of hydrogen atoms sharing their respective motions, the rods will equally obey the Lorentz transformation whether the atoms are Dirac atoms or Schrödinger atoms. We have to go much more deeply into the general principles of relativity theory to obtain any useful guidance as to the form quantum theory must take.

A. S. EDDINGTON.

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[1] "Mathematical Theory of Relativity", § 66, p. 152.
[2] *Proc. Camb. Phil. Soc.*, **35**, 186 (1939).

Physiology and Ecology of Cuticle Colour in Insects

THE interesting article in NATURE of October 11, p. 428, by Dr. Hans Kalmus requires comment upon a number of points, but first a protest must be entered against the use of the word 'frequently' in evidence for a 'rule'. Other vague statements might well be given more precise definition, such as 'pale' or 'dark'. The complications of pattern introduce great difficulties: Is an insect (non-lepidopterous, to fall in with Dr. Kalmus's excision of this group from most of the argument) with strongly contrasted areas of dark and light, conforming to the type of disruptive pro-cryptic, or of aposematic, coloration, to be considered 'dark' or 'pale'? Dr. Kalmus's criteria would seem to be applicable only to unicolorous examples, or those of which the pattern gives a fairly uniform result, and thus must exclude immense numbers of insects.

The difficulties of applying Dr. Kalmus's 'rules' are great. For example, in the dry Ngamiland country of South Africa, I found large scavenging black Tenebrionid beetles running about in the hottest sun: equally large black and active predatory Carabids appear after dark, but another large predatory beetle, the black Cicindeline Manticora, hunts by day, as do a great number of its more brightly coloured relatives.

Among weevils, the hardness of many is proverbial, and experimental evidence by the late C. F. M. Swynnerton showed it to be decidedly of protective value. Yet some are 'pale', others 'dark'; some may be found freely exposed by day, others conceal themselves until night.

Among aquatic insects the Coleoptera might, on the whole, reasonably be classed as 'dark'. The much softer Hemiptera (Notonecta, Corixa, Naucoris) are 'pale', but the equally soft Nepa is very dark, or black. All may be found in the same pond. The explanation that dark cuticle is less easy to wet seems rather weak.

As regards the darkness of eggs, much more evidence is required. Contrast the dark eggs of the puss moth on willow leaves with the bright yellow eggs, on cabbage, of the cabbage white. The eggs of stick-insects (Phasmidæ) are notorious for their degree of cryptic resemblance to seeds in shape and colour: seeds are very often dark, and so are these eggs.

One would like to see figures in support of the statement that most non-black insects are found in the tropics: Are we to conclude that out of all non-black insects a majority occurs in the tropics, or that, of all insects in the tropics, a majority is non-black?

In connexion with the interesting point about liquid food, surely most aphids are not pale? One thinks of the black bean and dock aphids, and, at the moment, of a large bed of reed-mace, of which the leaves and stems are blackened with Aphis.

An interesting test of whether predators are darker than phytophagous species could be provided by a statistical study of two not widely separated families of Hemiptera—the predaceous Reduviidæ and the plant-sucking Coreidæ, which may be found side by side all over the world. Dr. Kalmus writes of the dark colour of the tse-tse fly. There are some twenty species of Glossina, and while some, such as *palpalis*, may be called 'dark', this term can scarcely be applied to *morsitans*. The former, inhabiting rain forest, can scarcely be said to be subject to the conditions of a dry region, while *morsitans*, in such a dry area as the Nuba mountains in southern Sudan, should be the darker species.

G. D. HALE CARPENTER.

University of Oxford.

I AM pleased that my article should have aroused the interest of such a well-known authority on adaptative coloration as Prof. G. D. Hale Carpenter. Before answering in detail, I should like to deal with his first general protest. He objects to the word "frequently" in formulating a rule and calls this a "vague" statement. It is interesting in this context to quote from a letter which I received from Dr. B.P. Uvarov, of the Imperial Institute of Entomology,

which he kindly permits me to use: criticizing the wording of these same rules he writes: "The dogmatic character of your rules . . . is the first weakness of your paper." So I think I have on the whole kept well between extremes such as formulating rigid laws or merely making "suggestions for observation" as suggested in the letter quoted above.

If I understand Prof. Hale Carpenter's second sentence, he also thinks it vague to describe an insect as "pale" or "dark". In particular he thinks that the "complications of pattern introduce great difficulties". Actually I think it is quite feasible to assess the total brightness of an insect, for example, by using a photo-cell, and it is usually very easy to say which of two related forms is the darker one. Species with light and dark areas of cuticle are very useful for study. They provide the best material for a comparison of the properties of light and dark cuticles. I have been informed that such an investigation is in progress in a physical laboratory in Great Britain.

My article did not deal with pattern, but only with colour. Radiant heat, desiccation, or any of the five physical factors mentioned in my article do not have very different effects on an insect, whether homogeneously coloured or speckled, provided it has the same total brightness.

Many of Prof. Hale Carpenter's points seem to me to be the kind of exceptions which prove the rules. I think the beetles of Ngamiland provide quite good examples for Rules 12 and 14 (drought and vagility). They are mostly conspicuously black, and the more brightly coloured Cicindelids may well show a metallic colour. A comparison of the colour and life-habits of weevils may be worth while, but as both the light and the dark forms are very hard, a different process of hardening seems to be at work.

I think Rule 11 can only be understood to mean that the proportion of non-black insects is greater in the tropics. Similarly, Rule 13 means in respect of the aphids that a high percentage of them is light. The cuticle of the black aphids, mentioned by Prof. Hale Carpenter, is quite light; only the body contents and the epidermal cells are pigmented. This can easily be demonstrated by pressing a black aphid (for example, the chrysanthemum aphid, *Macrosiphoniella sanborni*) between two bits of filter paper. The result is two dark spots and a hyaline cuticle. The colour of the Reduvidæ and Coreidæ would not seem to have much bearing on the problem, since they are also hemimetabolic insects (Rule 5) and probably most of their coloration is not situated in the cuticle. It would be interesting to find out whether the same is true of Nepa.

It is difficult to see what selective advantage can be ascribed to the notorious resemblance of the eggs of Phasmidæ to seeds. On the other hand, I think it is not surprising that an embryo, whether plant or insect, which has to resist the vicissitudes of a very similar environment, should show similar features. To my knowledge the humidity on a willow and a cabbage leaf have not yet been compared; but perhaps the fact that the puss moth has only one generation a year, whereas cabbage whites have several, could be interpreted by means of Rule 9.

I used a dark tse-tse fly merely as an example to show the difficulty in some cases of detecting the controlling factor in coloration, and I quite agree with Prof. Hale Carpenter's remark in his second paragraph, that the difficulties in applying my rules are great. However, they are not greater than in any other new ecological subject. That the "ecogenotypical colour variation" of insects is indeed beginning to attract the interest of biologists appears not only from correspondence on the subject, which I receive almost daily, but also from a paper, which reached me after my article had been written, and from which the term "ecogenotypical" is taken (W. Hovanitz, *Ecology*, July, 1941). It deals precisely with the group of insects which I thought would offer the greatest difficulties for the application of my rules, namely with butterflies. Although in disagreement with some of my rules, Hovanitz concludes from the study of many species that "contrary to established dogma the adaptiveness of animal coloration need not only be 'protective' but may only be a secondary product of a more fundamental function in the physiology of the animal". He thinks further that the geographical centres of pigmentation "are shown to be centres of certain physical conditions such as aridity, high temperature, etc., though they might more specifically have been said to be centres of low precipitation, low humidity, high temperature, high solar radiation, fast animal development and light coloured soil".

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Number of Primes and Probability Considerations

IN the first sentence of Lord Cherwell's communication[1] occurs the phrase "a number chosen at random"; and the applicability of the theory of probability surely depends on the possibility of random choice. Now an integer can be chosen at random from any finite set, but there is no way of choosing one at random from the infinite set of all positive integers. Thus if Lord Cherwell chooses an integer "at random" it will certainly be less than $10^{10^{10}}$, as otherwise he will not live long enough to write it down. But the probability that an integer chosen at random is less than $10^{10^{10}}$ is zero.

Hence, though we may use probability theory heuristically in the theory of numbers, and although it sometimes gives correct results, we have no logical grounds for supposing it will do so. Perhaps a set of axioms could be produced which would enable us to apply probability theory, but such a set would not, I think, include the phrase "a number chosen at random". Until this is done it is not obvious where to look for the weak link in the chain of reasoning when probability theory gives an incorrect result. We can, of course, apply probability theory to everywhere-dense infinite sets, such as the real or algebraic numbers in an interval, but in this case we never deal with an individual number, but only with a sub-interval. We biometricians have our difficulties, but at least the number of men, or even of bacteria, is finite, so biometrical sampling theory can be given a comparatively secure logical basis.

J. B. S. HALDANE.

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Harpenden, Herts.

[1] NATURE, 148, 436 (1941).

IN NATURE of October 11, p. 436, Lord Cherwell calculates, by considerations of probability, the number of primes in an interval Δ and finds that the correct answer is about 11 per cent smaller than his results.

Having myself calculated the number of primes by the probability method some time ago, I think I can give an explanation of the difference.

The probability for a number to be prime

$$\bar{\omega}_n = (1-\tfrac{1}{2})(1-\tfrac{1}{3})(1-\tfrac{1}{5})(1-\tfrac{1}{7})(1-\tfrac{1}{11}) \ldots \left(1-\frac{1}{p_n}\right)$$

is valuable only for the whole interval between p_n and $(p_{n+1})^2$. But Lord Cherwell applies it—or one derived from it—to an interval which is only part of the preceding. And the different parts of the $p_n-(p_{n+1})^2$ interval are not equally rich in primes. The higher parts are comparatively poor in primes. Thus, applying to the higher parts of the interval a formula which is valuable only for the comparatively richer whole interval, Lord Cherwell very naturally finds a number of primes which is slightly too great.

On the contrary, when the formula is applied to the correct interval [p_n to $(p_{n+1})^2$] the agreement becomes rapidly very good as p_n increases, as is shown by the accompanying table.

Prime numbers		Interval	Probability of being prime for a number in the interval Δ_n	Number of primes in the interval Δ_n		Difference %
p_n	p_{n+1}	$\Delta_n=(p_{n+1})^2-p_n$	$\bar{\omega}_n = (1-\frac{1}{2})(1-\frac{1}{3})(1-\frac{1}{5}) \ldots \left(1-\frac{1}{p_n}\right)$	Calculated by $N = \bar{\omega}_n\Delta$	Actual	
2	3	9 − 2 = 7	0·5	3·5	3	+16·7
3	5	25 − 3 = 22	0·3333 . . .	7·333 . . .	7	+ 4·6
5	7	49 − 5 = 44	0·2666 . . .	11·733	12	− 2·2
7	11	121 − 7 = 114	0·2286	26·055	26	+ 0·2
11	13	169 − 11 = 158	0·2078	32·830	34	− 3·4
13	17	289 − 13 = 276	0·1918	52·936	55	− 3·8
17	19	361 − 17 = 344	0·1805	62·097	65	− 4·5
19	23	529 − 19 = 510	0·1710	87·216	91	− 4·2
23	29	841 − 23 = 818	0·1636	133·80	135	− 0·9
29	31	961 − 29 = 932	0·1579	147·20	150	− 1·9
31	37	1369 − 31 = 1338	0·1528	204·50	202	+ 1·2
37	41	1681 − 37 = 1644	0·1487	244·02	244	+ 0·008
41	43	1849 − 41 = 1808	0·1455	263·01	262	+ 0·4
43	47	2209 − 43 = 2166	0·1421	307·77	307	+ 0·25
47	53	2809 − 47 = 2762	0·1391	384·10	385	− 0·25
53	59	3481 − 53 = 3428	0·1364	467·71	461	+ 1·5
59	61	3721 − 59 = 3662	0·1341	491·18	491	+ 0·03
61	67	4489 − 61 = 4428	0·1319	584·18	580	+ 0·7
67	71	5041 − 67 = 4974	0·1300	646·43	646	+ 0·07
71	73	5329 − 71 = 5258	0·1281	673·70	673	+ 0·1
73	79	6241 − 73 = 6168	0·1264	779·47	777	+ 0·3
79	83	6889 − 79 = 6810	0·1248	849·70	848	+ 0·2
83	89	7921 − 83 = 7838	0·1233	966·18	966	+ 0·02
89	97	9409 − 89 = 9320	0·1219	1136·0	1129	+ 0·6

Of course the probabilities of divisibility are strictly independent and it cannot be any question of a mysterious tendency of the factors to avoid each other.

A FREE FRENCH SCIENTIST.

October 13.

"A FREE FRENCH SCIENTIST" appears to use the word 'probability' in an unconventional sense. The probability that a number in the neighbourhood of a large number A should be a perfect square tends to $\frac{1}{2\sqrt{A}}$; this is an obvious property of numbers in the neighbourhood A; it is not a matter of intervals. A "Free French Scientist's" expression does not give the probability of a number in the neighbourhood of a large number N^2 being prime, but the average value of the probabilities between p_n and $(p_{n+1})^2$.

The agreement he finds is unfortunately spurious. According to well-established theory the number of primes in his interval would be approximately $\mathrm{li}\,(p_{n+1})^2 - \mathrm{li}\,p_n$. In the region he has examined in his table this happens to be about 10 per cent bigger than $\frac{p_{n+1}}{2 \log p_{n+1}}$ and therefore nearly equal to $\frac{p_{n+1}}{e^{\gamma} \log p_{n+1}}$. But this is because he chanced to stop at 97. If he had proceeded to larger numbers the agreement would vanish and he would find a discrepancy just as serious as the one to which I directed attention.

Incidentally, my use of the word 'avoid' seems to trouble the "Free French Scientist" unnecessarily. Perfect squares avoid one another more and more the further we go, but there is nothing mysterious about this.

While I can sympathize with Prof. Haldane's very human wish to begin a metaphysical discussion, I had not expected him to reveal the urge quite so soon after his letter extolling utilitarian studies as opposed to pure science. Unfortunately, I do not feel I ought to indulge him, since his difficulties are quite irrelevant to the point at issue. The discrepancy to which I directed attention can be derived perfectly well by choosing a number at random from a finite class.

CHERWELL.

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Penetration of a Water-soluble Sulphonamide, Sodium Sulphacetamide (Albucid-soluble) into the Eyes of Rabbits

RECENT work has shown that the local application of sodium sulphacetamide can control the development of experimental corneal ulcers in rabbits (Robson and Scott[1]). This sulphonamide is also being used clinically in concentrations up to 30 per cent for the treatment of various ocular infections, and especially of hypopyon ulcers, and it became of interest to determine the concentration attained in the various ocular tissues, when solutions are applied locally to the conjunctival sac.

Experiments were performed on twenty-eight mature rabbits. Under ether anæsthesia, celluloid

funnels were put into one or both eyes and kept in position by means of purse string sutures through the lids (see Fig. 1). The funnel was so designed that its aperture had a diameter greater than that of the cornea. The flange therefore lay against the conjunctiva overlying the sclera, and no part of the funnel was in contact with the cornea. The solution of sodium sulphacetamide (2·5 or 30 per cent) was poured into the funnels and allowed to remain in contact with the eye for periods ranging from 5 to 30 min. The eyes were then removed, washed in saline and rapidly dried on blotting-paper. The aqueous humor was then withdrawn and the tissues dissected off, washed in saline and rapidly dried on blotting-paper.

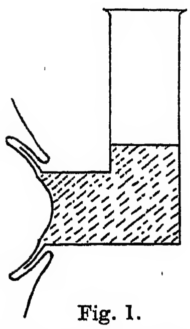

Fig. 1.

DIAGRAM TO SHOW POSITION OF FUNNEL IN CONJUNCTIVAL SAC.

The sodium sulphacetamide content of the tissues was then determined colorimetrically by the method of Marshall and Litchfield[2], with slight modifications. The results are shown in Figs. 2 and 3.

Each point on the graphs represents the mean of the values obtained in 5–10 experiments. There was considerable individual variation but certain facts nevertheless stand out quite clearly.

The concentrations in the cornea and conjunctiva are very similar and much higher, as was to be expected, than that found in the aqueous. The values for the iris were still smaller. The drug penetrates into the cornea and conjunctiva very rapidly

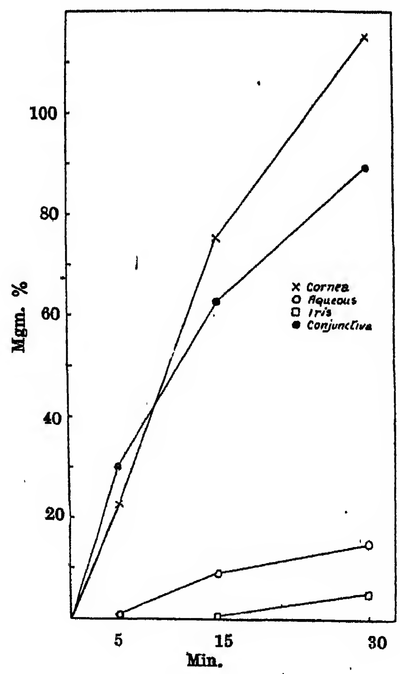

Fig. 2.

CONCENTRATIONS OF SODIUM SULPHACETAMIDE (MGM. %) ATTAINED IN OCULAR TISSUES AT VARIOUS PERIODS AFTER THE BEGINNING OF APPLICATION OF A 2·5 PER CENT SOLUTION OF THE DRUG TO THE CONJUNCTIVAL SAC.

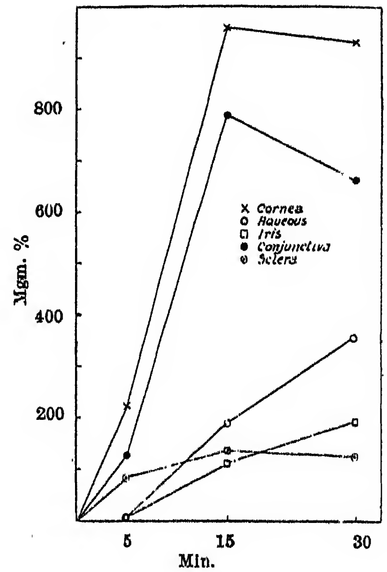

Fig. 3.

CONCENTRATIONS OF SODIUM SULPHACETAMIDE (MGM. %) ATTAINED IN OCULAR TISSUES AT VARIOUS PERIODS AFTER THE BEGINNING OF APPLICATION OF A 30 PER CENT SOLUTION OF THE DRUG TO THE CONJUNCTIVAL SAC.

and very high concentrations can be produced, either by applying the 30 per cent solution for a short period, or by applying the 2·5 per cent solution for longer periods.

Application of the 30 per cent solution (which is hypertonic) for fifteen minutes or more produced some degree of œdema of the cornea, and this may be responsible for the failure of the concentration of the drug in the cornea to rise any further.

Only small amounts of the drug were found in the vitreous humor and there was practically no penetration of the drug into the lens. In a number of experiments the concentration of the drug in the blood was determined. The highest value obtained was 7 mgm. per cent after the application of the 30 per cent solution for 30 min.; but in most cases it was much smaller. These low values show that direct penetration of the drug was responsible for the high values found in the ocular tissues.

These results, like those of P'an[3], suggest that local application of sulphonamides is the method of choice for the production of adequate concentrations of the drug in the ocular tissues and for the treatment of certain ocular conditions by sulphonamides.

The expenses of this investigation have been defrayed by the W. H. Ross Foundation for the Prevention of Blindness. We are greatly indebted to Mr. Edwards of British Schering Ltd. for the supply of a 30 per cent solution of albucid soluble.

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[1] Robson, J. M., and Scott, G. I., NATURE, 148, 167 (1941).
[2] Marshall, E. K., and Litchfield, J. T., *Science*, 88, 85 (1938).
[3] P'an, S.Y., *Proc. Soc. Exp. Biol.*, 46, 31 (1941).

RESEARCH ITEMS

Ancient Indian Cultures

AN article by M. E. and D. H. Gordon (*J. Roy. Asiatic Soc. Bengal*, 6, No. 2 ; 1940) contains interesting information concerning their studies in the Indus valley. The prehistoric cultures exemplified by Harappa and Mohenjo-daro are not necessarily isolated from those of the early historic period, as certain objects have been found in mounds in Peshawar and other neighbouring districts which appear to carry on the ancient traditions. Moreover, painted pottery such as is found in these mounds is made in all the same localities to this day. This does not mean that there is no distinction between the present-day painted pots and those of the early historic periods; but there are certainly similarities, which, with the other evidence put forth, tends to show that there is no hiatus of 2,000 years in these Indian cultures. Ancient metal and stone workings in the eastern portion of Chota Nagpur have been excavated by E. F. O. Murray and described in "The Ancient Workers of Western Dhalbhum" (*ibid.*). The ethnology and geology of the district are dealt with briefly and a description given of the very interesting finds of pottery, beads and stone implements. The old mines are also described. The author concludes that they belong to an ancient culture of a higher level than that attained by the present inhabitants of the region.

Nicotine Accumulation in Reciprocal Grafts of Tomato and Tobacco

THE distribution of nicotine between stock and scion in reciprocal grafts of tomato and tobacco was described by R. F. Dawson at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. When tobacco scions were grown upon tomato stocks no appreciable amounts of nicotine accumulated in the tobacco leaves or stems. In fact, the nicotine which was originally present in the scions remained in the lower leaves and stems, and the leaf and stem tissues which afterwards developed were nicotine free. When tomato scions were grown upon tobacco stocks nicotine was found in appreciable quantities in the tomato stems and fruits, and large quantities of the alkaloid accumulated in the leaves. Nicotine accumulation in the leaves of the tomato scions was sectoral when tobacco stems were decapitated and inserted into the tomato stems unilaterally. Nicotine was isolated from the xylem and the xylem exudate of the stems of intact tobacco plants. The evidence indicates that the presence of nicotine in tobacco leaves is due to (*a*) the synthesis of the alkaloid in the tobacco roots, (*b*) the translocation of the fully formed base (and not its precursor) to the leaves by way of the xylem, and (*c*) the continued accumulation of this nicotine in the leaves.

Microscopic Structure of the Wool Fibre

A SERIES of twenty-seven microphotographs forms a special feature of a study of the fine details of structure of wool fibres by C. W. Hock, R. C. Ramsay and M. Harris (*J. Res. Nat. Bur. Standards*, Washington, D.C., 27, 181 ; 1941). Special attention was given to constituent scale and cortical cells. The individual cells were released by treating chemically modified wool with pepsin. The striated appearance of the cortical cells is due to the presence of many fibrils which can be separated with microneedles. Between crossed nicols the fibrillar part of the cortical cells appears birefringent whereas the nucleus does not. The scales show little internal organization and appear non-birefringent between crossed nicols. A comparison of root and shaft of the fibre reveals many differences in reaction to microchemical colour tests as well as differences in cellular structure. The paper can be obtained also as Research Paper *R.P.* 1412 [10c] from the Superintendent of Documents, Washington, D.C.

Heat of Sublimation of Carbon and Absorption Bands of Three Mesomeric Hydrocarbons

SPECTROSCOPIC analysis of the CO spectrum, together with thermochemical measurements on the burning of carbon in oxygen, lead to the conclusion that L, the heat of sublimation of carbon, is either 124 or 170 kcal./mol. G. J. Kynch and W. G. Penney (*Proc. Roy. Soc.*, A, 179, 214; 1941) have made an estimate of L by calculating the energies of excited states of benzene, butadiene and hexatriene. Various values of L were assumed and the calculations were compared with experiment. Almost exact agreement was found for all three substances by assuming $L = 170$, and no agreement was found by assuming $L = 124$. The theory used is similar to that developed by Eyring for estimating activation energies. The equilibrium internuclear distances in the excited states are found, and the potential function controlling some of the vibrations about these positions is determined. The excited state of benzene has the regular hexagon configuration, with the carbon-carbon internuclear distance 1·45 A., compared with 1·39 A. in the ground state. The carbon-breathing frequency in the excited state is calculated to be 920 cm.$^{-1}$, compared with the experimental value 940 cm.$^{-1}$.

Preparation of Deoxycholic Acid

THE preparation of deoxycholic acid from cholic acid was described by T. F. Gallagher and W. P. Long at the Autumn Meeting of the U.S. National Academy of Science held during October 13–15. When methyl cholate is oxidized at low temperatures with chromic oxide, the principal product is the methyl ester of 3-12-dihydroxy-7-keto-cholanic-acid, hitherto undescribed. A method for separation of this compound is given. Upon reduction by the method of Wolff-Kishner it is converted smoothly to deoxycholic acid in excellent yield.

Structure of Soap Curd Fibres

SOME interesting photographs of the curd fibres of sodium laurate have been obtained by L. Marton, J. W. McBain and R. D. Vold (*J. Amer. Chem. Soc.*, 63, 1990 ; 1941) by means of the electron microscope with direct magnification up to 19,000 diameters. The results confirm previous conclusions based on less direct evidence. The curd is shown to consist of a mass of fibres which are thin ribbons with widths tending to be integral multiples of approximately twice the length of the sodium laurate molecules. In order that the carboxylate groups and methylene groups, respectively, may be adjacent to one another

in the manner found by X-rays for the monoclinic crystals, it would be expected that the fibres should be much wider than they are thick, and this agrees with the microscopic result. The fibres branch to form a felt, which accounts for the rigidity of the curd. The fibre junctions are also seen to give rise to many capillary spaces of variable diameter in which water can be retained, even at very low relative humidity. Some of the sodium laurate apparently is not a part of the fibrous structure but is present in granules 100–200 A. in diameter irregularly spaced along the fibre. These were perhaps formed by rapid dehydration, during exposure of minute drops of solution, or may be related to aggregates pre-existing in the soap solution.

Effect of Ions on the Liquid Structure of Water

G. W. Stewart, in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15, discussed the effect of ions on the liquid structure of water. Water is unique in its liquid structure, and the influence of ions in solution on this structure becomes important experimental evidence. The results represent a considerable extension of an earlier report, and the conclusions therefrom are as follows: (1) With 41 strong electrolytes (so named in I.C. tables), out of a possible of approximately 200, the alteration in the X-ray diffraction pattern indicated that the ions caused an increase in the co-ordination bonds of the solvent water with a contraction in its volume. (2) With 37 of these, there was a rough but striking correlation between the rate of change of apparent molal ionic volume with concentration and the rate of change of the X-ray structure with concentration, the latter being determined in a somewhat arbitrary but consistent manner. The number of electrolytes was limited by the desirability of using only the lighter atoms. (3) With 3 of the strong electrolytes the rate of change of the apparent molal ionic volume occurred in the opposite direction although the change in water structure was similar to that with the others. The conclusion is that there are other factors in these special cases (the total number is only 6 in 200) which have the effect of decreasing the apparent molal ionic volume. Quantitatively, ionic temporary pairing might be such a factor. (4) There is a rough correspondence between the solubility of these electrolytes and their effect upon the structure of the water, the less the effect on the structure the greater being the solubility. (5) All these results are consistent with and seem to emphasize the tetrahedral structure of water changing with increasing temperature, this structure and these changes accounting for some of the unique characteristics of water.

New Compounds Fluorescent to X-Rays

New compounds fluorescent to X-rays consisting of pure isomorphous mixtures of the sulphates of barium and lead, have been discovered in the research laboratories of Ilford Limited by F. F. Renwick and H. S. Tasker, and form the subject matter of a recently issued British Patent No. 540,252. These materials, it is claimed, emit a strong violet and ultra-violet fluorescence, without afterglow when excited by X-rays, but show no fluorescence under ultra-violet light illumination. Being insoluble and inert towards photographic emulsions, they are likely to prove valuable, not only for the manufacture of X-ray intensifying screens, but also in composite units embodying both screen and emulsion on a single support. They appear, moreover, to be unique in that they can be prepared by double decomposition in an active micro-crystalline form by the simple interaction of a solution containing salts of barium and lead with a solution of a sulphate, without the necessity for a subsequent firing treatment, as is essential in the preparation of all the well-known fluorescent salts, such as calcium and other tungstates, zinc sulphide and zinc silicate. When a firing operation is also employed, their fluorescence is stated to be considerably enhanced, and products rivalling the most highly fluorescent calcium tungstates are said to be obtainable. This addition to the list of useful fluorescent compounds will doubtless interest not only radiologists but also those research workers who make a special study of fluorescence phenomena.

Bombardment Experiments with Protons on Boron

When boron is bombarded with protons, two groups of α-particles are found, one a group with continuous distribution in range and maximum range of 3·7 cm., the other a group with homogeneous range of 4·4 cm., according to A. Ellet and J. Jacobs in a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The excitation function of each group was studied in the range 100–200 kev., and in each case showed a resonance at 158 ± 3 kev. The resonance for the continuous group had not been previously found. The distribution in angle of each group at resonance and of the continuous group just above resonance (175 kev.) was measured. Both groups showed asymmetry at resonance (in agreement with previous reports); but the continuous group was observed to possess spherical symmetry above resonance (in contradiction to previous reports). The resonance yields of the α-particles of each group are presumed to have a common origin, a p- or d-proton capture. The non-resonance yield of the continuous group is presumed to arise from an s-type capture. The results are in agreement with certain theoretical considerations.

Maxima of Absorption Lines in Stellar Spectra

The maxima of absorption lines in stellar spectra were described by P. C. Keenan at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The accurate spectral types recently determined at the Yerkes Observatory for a large number of stars provided the basis for improved estimates of the spectral types (and corresponding effective temperatures) at which the stronger atomic lines and molecular bands reach their maximum intensity. In giant stars the neutral iron lines of *e.p.* 1·5v. show a maximum at type $K5$ ($T_e = 3600° \pm$) while those with *e.p.* 2·4v. are strongest near $K3$ ($T_e = 3850° \pm$). In dwarfs the behaviour of these lines is similar but less clearly differentiated. Among the lines of ionized elements which persist to low temperatures, the K-line of Ca^+ shows no marked falling off in strength through the coolest observable giants (type $M5$ with $T_e < 3000°$), but has a maximum for the dwarf stars near $K5$. Bands of CN are strongest at $K1$ in giants and at $G7$ in supergiants, while remaining weak in dwarfs at all temperatures. The $\lambda 4300$ band of the CH molecule behaves similarly, but has maxima about five spectral subdivisions earlier than those of CN.

MEDAL AWARDS OF THE ROYAL SOCIETY*

COPLEY MEDAL

THE Copley Medal has been awarded to Sir Thomas Lewis.

Lewis's life's work, still in vigorous progress but for interruption by war duties and war conditions, has been the application of precise and controlled methods of experimental research to problems of clinical medicine. This has enabled him to achieve a detailed analysis of abnormalities of function produced by disease, injury or hereditary defect; and so far his attention has been centred upon the circulation of the blood and its disorders. Being attracted through the work of the late Sir James Mackenzie to the study of abnormal rhythms of the human heart-beat, Lewis recognized, about 1908, the great opportunity for a closer investigation of them offered by the then recent introduction of the string galvanometer by Einthoven. With its aid Lewis had soon made a number of clinical and laboratory studies, such as those in which he finally identified auricular fibrillation as the cause of a particular kind of complex irregularity. He was thus led to undertake, and to extend, with a succession of collaborators from many countries, the remarkable series of investigations, carried through in logical sequence between 1910 and 1923, in which he passed from the laboratory to the clinic and back again as the occasion demanded.

It is fitting that special mention should here be made of the series of experimental studies published in the *Philosophical Transactions* during 1914–1916, and presented in brilliant summary by Lewis in his Croonian Lecture to the Society in 1917. In these were traced, with an astonishing precision of measurement and timing, the point of origin and exact course of the rhythmical waves of excitation and contraction in the normally beating heart of the dog, and, finally, for comparison, in the hearts of other classes of vertebrate animals. Considered by itself, this work ranks as one of the outstanding achievements of experimental physiology in our times, and it has given to physiology a large part of its present detailed knowledge of the nature of the heart-beat. For Lewis, however, its greater importance lay in giving to clinical medicine the background for an accurate picture of disturbances of the normal mechanism, therewith a new security of diagnosis and prognosis in dealing with disordered actions of the heart, and ultimately a rational basis for their treatment. A new phase of cardiological thought and practice spread rapidly from Lewis's clinic round the world.

Meanwhile he had begun in 1917, and was to maintain with a series of collaborators for more than another decade, a separate series of investigations, dealing by direct experiment with the blood vessels of the human skin. Thus were elucidated the means by which the resistance of these vessels to the flow of blood is maintained and varied, including their complex reactions to chemical substances akin to histamine, which he proved to be released from the cells of the epidermis by injuries or irritant stimuli. These methods of investigation were later developed and extended to vascular disorders of the limbs, and the experiments of still more recent series have dealt with pain and functional defects in muscles and nerves, due to interruption of the blood supply. Apart from the separate accounts of items and stages of those lines of research, as completed, in papers which have issued from his department in steady sequence, Lewis has assembled and discussed the results, in their appropriate connexions, in a succession of comprehensive monographs. He has been the inspiring leader of a group of younger workers in clinical research as an experimental science, has founded a Society for such studies and has devoted to their use a journal which he had started with a more limited scope.

The work of Thomas Lewis, which we honour today with the highest recognition in the gift of the Royal Society, is renewing and carrying forward, with a special directness, the great tradition which William Harvey created, before this Society was founded.

ROYAL MEDALS

A Royal Medal has been awarded to Prof. Edward Arthur Milne.

Milne is distinguished for his work on planetary and stellar atmospheres, on the internal constitution of the stars, and on the theory of relativity. An early paper on various properties of the earth's atmosphere, up to high levels, led later to a valuable improvement of the theory of the escape of planetary atmospheres by the passage of the faster moving molecules out of the range of the gravitational field. Thence he passed on to a long series of investigations on radiative equilibrium and the theory of the atmospheres of the sun and stars.

Next, partly in collaboration with R. H. Fowler, he improved and extended Saha's theory of the absorption lines in stellar spectra, obtaining a relation between the maximum strength of a line and the mean pressure and temperature in the atmosphere. Afterwards Milne generalized this theory, providing a rational foundation for the astronomers' empirical method of determining stellar parallaxes from the spectra.

Later he considered the equilibrium of the calcium chromosphere of the sun, and also discovered a method by which outward-moving atoms capable of absorbing radiation in the region of the chief absorption lines can be accelerated and pass beyond the range of the sun's attraction, attaining a limiting speed of about a thousand miles a second. This theory also has an application to 'new' stars.

Milne then considered the deeper layers of the atmosphere (for example, in the case of the sun, the photosphere), which in 1929 he took as the subject of his valuable Bakerian Lecture. He has also given a theory of the structure of sunspots and of the circulation associated with them.

In 1929 he began a new series of researches on the radiative equilibrium of gas spheres, designed to improve the theory of the internal constitution of the stars. His work in this field was specially important in focusing attention on the properties of degenerate matter.

In 1932 Milne began an altogether different series of investigations, bearing on the largest topics of astronomy and cosmogony, and providing an alternative

* From remarks made by Sir Henry Dale in presenting the medals for 1941.

to the general theory of relativity developed by Einstein and his followers. He has made a valuable analysis of the concept of time, and his kinematical theory of gravitation has some promise of a possible extension to include also electromagnetism.

Milne's later work has been the subject of much controversy: but the originality and boldness of his attack seem certain to promote our understanding of these great problems.

A Royal Medal has been awarded to Prof. Ernest Laurence Kennaway.

Kennaway is the director of the Chester Beatty Research Institute of the Royal Cancer Hospital, and has been engaged for the past twenty years in investigations on the production of cancers by the continued effects of chemical agents. The long-known liability to skin cancer of men whose work involves regular contact with soot, coal tar, or pitch, and the more recently demonstrated production of such cancers in animals by painting the skin with tar, had raised the question whether a specific chemical agent was concerned, or only a sufficiently persistent irritation. The fractionation of coal tar, in search of a substance revealing its action only after tedious months of experiment, was an undertaking to daunt any but a devoted investigator. Kennaway embarked on this quest, and after years of labour the fluorescence studies of his co-workers Mayneord and Hieger made it possible to isolate a pure substance from tar with intense carcinogenic activity, and ultimately to identify it as benzpyrene. This identification and its confirmation by synthesis were due to J. W. Cook.

Meanwhile, the observation that active fractions of the tar had ultra-violet fluorescence spectra resembling those of hydrocarbons of the phenanthrene type, led to the synthesis of substances with carcinogenic activity. The first of these was a dibenzanthracene, and was found to be almost as active as benzpyrene. Substances of still greater activity have since been obtained, and some of these have a close structural relationship to naturally occurring sterols. A characteristic nuclear ring-complex thus, surprisingly, provides a link of structural community between these carcinogenic agents and a number of natural substances having intense but widely different biological activities—the D vitamin, a number of hormones concerned with sexual functions, and the highly toxic but remedially important glucosides of the digitalis series. One of the most fascinating chapters in organic and biological chemistry has been opened. Identification of these provocative agents does not tell us how they act, and the causes of seemingly spontaneous cancers remain as yet obscure. It cannot be doubted, however, that, when further advances of knowledge enable a correct account to be written of the nature and mode of origin of the malignant tumours, the pioneer work of Kennaway and his able group of co-workers will provide one of the important chapters.

DAVY MEDAL

The Davy Medal has been awarded to Dr. Henry Drysdale Dakin.

Dakin began his researches in the field of biochemistry early in the present century. At that time, in comparison with knowledge of the end-products of metabolism, relatively little was known about the chemical activities of the living cells of the animal body. His work has made very important additions to knowledge of the intermediary changes produced by these activities, and also of the chemical structure of natural components of the tissues.

One side of Dakin's work has dealt with enzymes of the animal organs. He was the first to show that such an enzyme will attack at different rates the two optical isomers in a racemic mixture. With Kossel he discovered the enzyme arginase, with its important role in the production of urea from arginine. Later he discovered the enzyme glyoxalase, the wide distribution of which in the tissues must indicate some important though still undefined function in carbohydrate metabolism.

In connexion with the intermediary metabolism of fatty acids, Dakin produced the first convincing evidence of oxidation at the β-carbon atom as the first stage of their utilization by the body, and showed that this type of oxidation can even be reproduced *in vitro* by the action of hydrogen peroxide.

Dakin's work on the chemistry of the proteins has included a method of partial racemization, bringing subtle differences of molecular pattern into view, which could be related to specific antigenic differences. He also introduced a method of separation which enabled new hydroxyamino acids to be recognized, and raised much nearer to unity the proportion of a protein molecule accounted for as known amino-acids. At a wide interval of years, Dakin has made two notable contributions to the chemistry of hormones. In 1905, he was rosonsible for the first published artificial synthesis of a hormone, adrenaline. In 1936 he described the isolation from liver of a substance which is, at least, a principal factor in the important effect of liver extracts on pernicious anæmia.

Working in France during the War of 1914–18, Dakin introduced the use of a buffered hypochlorite solution for irrigating infected wounds. Later, on a ship bringing the sick and wounded from Gallipoli, he made a similar solution by direct electrolysis of sea-water. Another war is reviving the use of such preparations to meet the same and other needs.

Though Dakin has worked in a private laboratory, with but rare collaboration and no pupils, his work has exercised a wide and powerful influence on the growth of biochemistry and on the strengthening of its links with organic chemistry.

HUGHES MEDAL

The Hughes Medal has been awarded to Prof. Nevill Francis Mott.

Early in his career Mott's work in the field of atomic collisions attracted widespread attention. He was the first to show that Rutherford's scattering law holds in quantum mechanics, and to give an accurate theory of the effect of symmetry in scattering problems. When he took up his present post as professor of theoretical physics in the University of Bristol, he abandoned this subject for that of the theory of metals and alloys. Within a few years he was recognized as one of the leading international authorities in this field, to which he contributed a number of important papers on electronic bands in metals and on the electrical conductivity of alloys and its temperature coefficient. In establishing a close association between theoretical and experimental workers he has no superior. He also contributed to the important problem of metals under strain; under his direction Fuchs has calculated the elastic constants of certain metals and obtained good agreement with known values.

Later Mott turned to semi-conductors and insulators, throwing light on the physical processes involved in the formation of oxide films, and in the electrical conductivity which can be induced by various means in polar crystals. His theory (with Gurney) of the formation of the latent image in a photographic emulsion has found general acceptance, and has stimulated fresh experimental work in research departments of the industry.

This striking record of published work was achieved between 1928 and 1939.

When war broke out Mott found that his activities as a quantum physicist had no direct application to the War. It is a tribute to his versatility and flexibility of mind that he could turn so quickly to a new field in classical physics, and make important contributions to the practical problem in connexion with which he now holds an important post.

ABORIGINAL AUSTRALIAN STRING FIGURES

As time goes on, more and more attention is given to primitive man in his physical, mental and cultural aspects, and among the last-named may be classed that singularly fascinating and complicated pursuit known to us as string figures. It is now nearly forty years since the first collection of string figures was made and described from Torres Straits by Rivers and Haddon, and since then there has been a steady interest in the subject and a mounting number of collections made in different parts of the world. The latest is embodied in an article by D. S. Davidson (*Proc. Amer. Phil. Soc.*, 84, No. 6; Aug. 1941) in which he sums up our present knowledge of the subject and adds a most interesting collection made by him from the Australian aborigines.

That a goodly store was to be collected there was evident from Roth's illustrations of numerous Queensland figures, unfortunately without directions for their making, published in 1902; from some collected by myself from a few restricted areas in 1914, and from Stanley's collections, again from north Queensland, in 1926. Mr. Davidson's studies form a much-needed addition to our knowledge of the subject and are the more valuable in that he traces the possible connexions of these Australian figures with those occurring in other parts of Oceania. According to his conclusions, string figures are of comparatively recent introduction into Australia from Melanesia, as they are found in greatest numbers in north-west Queensland, whereas in Western Australia they are almost lacking and what exist are of recent introduction.

Mr. Davidson considers that Australia, Melanesia, Micronesia and Polynesia comprise a major string-figure area, and from the evidence of the string figures themselves suggests the possibility that they were brought into the Pacific by the Polynesians or Micronesians, and spread from the west into New Guinea and western Melanesia late in the pre-Polynesian period. He suggests also that the diffusion of string figures into the New World and Africa from some Asiatic point of origin might have taken several thousands of years, but he does not appear to consider their possible spontaneous generation in unrelated areas. This is known to have occurred recently among the Brahmins in India and seems likely to be an explanation of their world-wide distribution, seeing that string—or its equivalent—is co-existent with man.

Mr. Davidson has described and illustrated some seventy string figures and in addition gives a comparative chart of their distribution; there is also a bibliography. If one might venture a criticism of one of his descriptions, taking a loop off a digit would seem to indicate removing it, whereas in "Movement Z" it means making the loop common to right and left thumbs. But this is a detail and in no way impairs the interest and value of the contribution.

K. Rishbeth.

THE MOA IN NEW ZEALAND

A recent valuable contribution to the natural history of New Zealand by Dr. G. Archey dealing with the moa* fully maintains the high reputation of the ornithologists of that country, and both the author and the Council of the Auckland Institute, who sponsored the work, merit our congratulations.

Almost from its inception the study of the moas has been accompanied by considerable confusion and uncertainty owing to the insufficient definition of types, and to the frequently erroneous association of different parts of the skeleton, an unsatisfactory state of affairs which Dr. Archey determined to remedy. After much patient work involving the examination of types and other specimens both in New Zealand and in England he has produced this excellent monograph of the moas.

Perhaps the most urgent need was for a knowledge of the associated skeleton in the various forms, and in accumulating material for this the author tells how greatly he was helped by many enthusiastic field workers who, since 1930, have discovered and collected in different parts of the North and South Islands no less than fifty fairly complete skeletons, and more than a hundred partial sets of bones of individual birds. Among the facts revealed by this mass of authentic associated material is the hitherto unsuspected occurrence of parallelism in one division of the moas. The author writes ". . . that two subfamilies with widely differing skulls, sterna and phalanges have independently embarked upon identical courses of development of shorter and heavier

* The Moa: a Study of the Dinornithiformes. By Gilbert Archey. Bulletin of the Auckland Institute and Museum, No. 1. Pp. 119+15 plates+9 tables of Measurements. (Auckland: Auckland Institute and Museum, 1941.)

leg-bones" (p. 8). Good evidence is supplied in support of the claim that from the characters of both skull and skeleton the moas can be separated into two natural divisions: "the tall Dinornithidæ, with flattened broad skulls and the normal number of phalanges, are regarded as standing apart from the others." The second division absorbs the remainder, which thus includes a considerable number of genera and species. These two sections are the equivalent of Dr. Oliver's Dinornithidæ and Anomalopterygidæ. Careful diagnoses and descriptions are given of the genera and species, and these greatly help to bring order into this rather unwieldy group. In habits these birds appear to have been tolerant of different climatic conditions, vegetarian in their diet, and dwellers in open scrub and grassland. Dr. Archey refuses to credit the great Dinornis with a maximum height of twelve feet, and thinks that it cannot have exceeded a normal walking height of ten feet. The phylogeny of the moas is of paramount interest, being related to the problem of the origin of all the large flightless birds, but the author does little more than review this subject, although he seems inclined to cling to the belief in a loss of flight through degeneracy. Dr. Percy Lowe's brilliant anatomical researches, coupled with the discovery of an ever-increasing number of large fossil flightless birds in nearly every region of the globe, forces this old belief to appear in a somewhat fantastic light.

The last section of the book, entitled "Development and Extinction", includes much diverse information. The author concludes that the evidence all points to the "final extermination of the Moa by the earliest Polynesian immigrants a considerable time ago, first in the North Island and later in the South, and probably before the arrival of the immediate ancestors of the present Maori tribes in the Fleet migration of 600 years ago" (p. 97). There are also new and interesting details about the occurrence of the remains, notes on recent geological happenings affecting the moas, and so forth. The volume is completed with a comprehensive bibliography, a series of tables of measurements of limb bones, and fifteen plates. This brief notice should serve to show that this is a volume which will be indispensable to every serious ornithologist.

D. M. A. BATE.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, DECEMBER 6

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Dr. W. G. Wearmouth: "Physical Problems in the Plastics Industry".

MONDAY, DECEMBER 8

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Lieut. L. G. Trorey: "Photographic Survey by High Obliques; the Canadian Plotter and Crone's Graphical Solution".

TUESDAY, DECEMBER 9

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Mrs. Blaise Gillie: "Post-War Housing in the Light of War-Time Experience".*

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Mr. R. Maxted: "Infra-Red Radiation and Equipment, their Application to Industrial Processes".

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institutions of Civil and Electrical Engineers) (at Central Hall, Westminster, London, S.W.1), at 10.45 a.m.—Conference on "Air Raid Precautions and the Engineering Industry".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

WEDNESDAY, DECEMBER 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Miss Elizabeth Denby: "The Post-War Home—Its Interior and Equipment". 2: "Using Space to Advantage".

PHYSICAL SOCIETY (COLOUR GROUP) (at the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2), at 2.35 p.m.—Dr. F. H. G. Pitt: "Colour Blindness and its Importance in Industry".

THURSDAY, DECEMBER 11

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Mr. Thomas Tickle: "The Influence of Analytical Chemistry on Pharmacy" (Harrison Memorial Lecture).

FRIDAY, DECEMBER 12

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. A. Caress: "Plastics and Engineering".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PROFESSOR OF AGRICULTURE—The Principal, University College of Wales, Aberystwyth (January 15).

JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by the Government of Sierra Leone—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.330).

FIRST ASSISTANT PORT ENGINEER for the Basrah Port Directorate, Government of Iraq—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.340).

SECOND ASSISTANT PORT ENGINEER for the Basrah Port Directorate, Government of Iraq—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.341).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by the Government of Sierra Leone—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.345).

ASSISTANT ENGINEER (CIVIL) for the Gold Coast Government Railway—The Ministry of Labour and National Service, Central Register Branch, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E.346).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Interim Scheme for the Training and Resettlement of Disabled Persons. Pp. 8. (London: Ministry of Labour and National Service.) [411

University of London: University College. Calendar, Session 1941–1942. Pp. lxiv+228+lxv–lxxviii. (London: Taylor and Francis, Ltd.) [1111

Other Countries

Brooklyn Botanic Garden Record. Vol. 30, No. 4: Prospectus of Courses, Lectures and other Educational Advantages offered to Members and to the General Public, 1941–1942. Pp. vi+225–251. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [311

Trinidad and Tobago: Forest Department. Administration Report of the Conservator of Forests for the Year 1940. Pp. 6. (Trinidad: Government Printer.) 6*d*. [311

Government of Travancore. Administration Report of the Government Museum, 1115 M.E. Pp. ii+8. (Trivandrum: Government Press.) [311

Smithsonian Miscellaneous Collections. Vol. 101, No. 4: Diseases and Artifacts on Skulls and Bones from Kodiak Island. By Aleš Hrdlička. (Publication 3640.) Pp. ii+14+11 plates. (Washington, D.C.: Smithsonian Institution.) [1011

Gold Coast Colony. Report on the Forest Department for the Year 1940–41. Pp. 6. (Accra: Government Printing Department; London: Crown Agents for the Colonies.) 1*s*. [1011

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NATURE

SATURDAY Dec. 13, 1941

HEALTH AND SOCIAL WELFARE

ALTHOUGH the health of the nation in war has recently been debated in both Houses of Parliament, the attention paid to the subject has scarcely been commensurate with its importance; indeed it might be held that in this matter Government action is in advance of public opinion. Upon the standard of health depends very largely the volume of production and also the quality of the Fighting Services, yet in the concern over absenteeism, as a report of the Select Committee on National Expenditure indicated, there has been little appreciation of the health factor as the result of excessive hours of work. The precious and vital asset of the good health of the industrial worker is yet to be fully appraised, even if we are more awake to the value of civilian health generally as a result of last winter's experiences.

A further encouraging picture of the nation's health generally has been given by the Chief Medical Officer of the Ministry of Health, while in the recent debate the Minister himself showed that the nation is entitled to congratulate itself on the avoidance of serious epidemics during the second as well as the first year of the War. This second year, moreover, included a period of intense air attack when large sections of the population lived in shelters, often insanitary, and in which material damage coupled with a large re-distribution of the population undoubtedly caused some overcrowding. That the public health has remained so good may well be more a matter of good fortune than of a well-planned policy for the health services, and there can clearly be no relaxation of vigilance. The Minister himself pointed out that good housing is the indispensable foundation of public health, and housing policy is necessarily in suspense.

It should be our first aim, therefore, to utilize this breathing space to adapt our health services to the harder conditions which may lie ahead, and two broadsheets issued by Political and Economic Planning (P E P) are welcome for their contribution to this end. The first of these, on "Health in War-time", points out that the problems of civilian health are potentially far more serious than in the War of 1914–18, mainly because the development of aerial warfare has made the wrecking of civilian community life and services a major objective in the attack on Britain. This is due not merely to the actual damage to public services, such as gas, water, electricity or sewers and consequent deterioration of public hygiene, or to hospitals and clinics, but also to the widespread existence of conditions making for fatigue and loss of satisfactory sleep, and to the indirect effects of the black-out in homes and work-places in reducing the supply of light and air and assisting the spread of air-borne infections.

The two major problems, however, are, as in 1914–18, how to ensure adequate nutrition and how to combat fatigue. The nutrition situation is still much better than in 1917–18, and the measures being taken by the Ministry of Food, of which the new scheme for extending the supply of meals and milk for school-children announced by Lord Woolton is a recent example, encourage the hope it may never deteriorate to the same extent. Confidence in this respect is strengthened by the evidence of co-ordinated policy and close collaboration not merely between the Ministry of Food and the Board of Education but also between the Ministry of Food and the Ministry of Transport, as indicated in a subsequent announcement regarding the rationalization of transport to eliminate avoidable cross-hauls and the control of transport of foodstuffs by the Ministry of Food.

The problem of fatigue is probably much more serious. It is estimated that the average adult has lost one hour's sleep a night, and in the bombed areas his sleep is less satisfying than in peacetime. Moreover, hundreds of thousands miss most of their sleep on a number of nights each month because of Home Guard, fire-watching or other civil defence duties. The ratio of civilian food intake to energy output has so far been reduced more from the output and less from the intake end than in 1914–18. Whether this will in the long run reduce physical resistance so as to lead to outbreaks of infection on a large scale is impossible to say. The situation is clearly fraught with long-term dangers and calls for the utmost vigilance, as well as fully justifying all the attention that Lord Woolton is able to give to the variety of diet and the character of nutrition as well as to its amount.

In such circumstances it is of the utmost importance to avoid any unnecessary taxing of health and strength whether in home life or in industry. For this reason alone the recent report of the Chief Inspector of Factories makes somewhat disquieting reading. The Senior Medical Inspector, it is true, finds no evidence that in general the health of the industrial worker has materially suffered in spite of all the adverse circumstances. Night work in itself is not lowering his physical standard, and the effect of long hours on production has led to some relaxation before it has had any real effect on the general health of the worker. Moreover, there is no evidence pointing to any appreciable number of accidents due to nervousness or jumpiness caused by air raids. The evidence is all the other way of courage and spirit in overcoming intense handicaps.

What is disturbing in this report is the evidence of close vigilance that is still required in respect of hours of work, and the alarming wastage of man-power and woman-power through preventible accidents. The question of long hours recurs throughout the report, and while many managements have learnt the lesson that excessive hours diminish production and that proper breaks and rest days are of great importance from the point of view of output alone, there is far too much evidence that other managements have forgotten or appreciate insufficiently the lessons of the War of 1914–18. The observations of the admirable report of the British Association for Labour Legislation issued last year on welfare and health in relation to hours of work and output in wartime remain pertinent. They are supported by a special report on the subject issued by the Industrial Health Research Board, as well as by evidence in the reports of the Select Committee on National Expenditure.

It is clear that in this matter greater stiffness in enforcing good labour conditions would promote production and efficiency as well as morale and health ; and a like observation applies to the question of accidents. Fatal accidents rose last year by 24 per cent and non-fatal accidents by 20 per cent over 1939, the figures for which were already 17 per cent and 7 per cent, respectively, higher than in 1938. This increase is attributed to relaxation of care, and particularly the neglect of training in accident prevention among the new industrial workers. While inspectors have to meet some criticism that accident prevention is rather an unworthy subject for consideration in war-time, when men in the Forces are taking every kind of risk, the criticism is unsound ; further, as the Chief Inspector points out, the Services are carefully trained not to take unnecessary risks.

What has yet to be realized by management, and sometimes also by workers, is the serious loss of output directly due to accidents caused by lack of reasonable care. This is a matter of increasing importance as the difficulty of replacement of workers and of parts increases. We cannot develop our full man-power and productive capacity until everything that foresight and sound management can suggest has been done to eliminate waste of this character.

This emphasis on the crucial importance of management in regard to health and efficiency is reflected in two other matters bearing on the health of the industrial worker to which reference is made in the same report. The Senior Medical Inspector stresses the need for the extension of a medical service in factories. Much yet remains to be done under the Factories (Medical and Welfare Services) Order of July 1940, and the increasing appointments of medical officers to factories will fail of their full effect without the goodwill and co-operation of both employers and employees. The

services of fully trained nurses have been greatly extended and they are entering industry in increasing numbers, and if the development of a comprehensive medical service in factories is a long-term policy which cannot be fully achieved in war-time, very considerable advances are none the less possible where managements are alive to the possibilities and realize the opportunities which are theirs through the responsibilities imposed in part under the necessity of civil defence.

The second matter which is one of the responsibilities of management is that of the provision of works canteens. To this subject a special section of the report is devoted. Rationing troubles, two- and three-shift working, travelling hardships, billeting, and bombed homes have made the works canteen an essential in war-time. The difficulties in regard to construction and equipment appear now largely to have been overcome, though resort to mobile canteens may be desirable where a policy of dispersal has aggravated the difficulties. Particularly among the smaller employers, conservatism remains an obstacle, and the factory inspectorate sees no alternative but the extension of communal feeding under the local authorities.

The question of canteens indeed illustrates the way in which the health of the industrial worker is linked up with that of the civil population. The extensions of the selective distribution recently announced by the Ministry of Food should in themselves give a direct impetus to the canteen movement, and the policy of redressing the grievances or inequalities which are inseparable in a uniform rationing system in this way is unquestionably sound. Before the end of the year, eighty-five per cent of miners will be receiving supplementary rations served out at the pithead, and the issue to heavy workers of special rations in their canteens or other catering establishments is sound from the health as well as from the production point of view.

These may be described as a short-time programme, but whether they and the long-term programme for the adequate feeding of children will prove effective depends on other factors—continued success in the Battle of the Atlantic, the rigorous elimination of waste, effective administration of the policy itself, and not least the progress of our own efforts to increase food production. The marriage of health and agriculture which is being realized under our eyes is one good thing that has come out of the War, like the fuller utilization of our rapidly advancing knowledge of nutrition. The P E P broadsheet rightly lays stress upon the great asset we possess in this respect compared with 1914, particularly through advances in chemotherapy, in blood transfusion techniques, in radiology, in the understanding of problems of industrial health and fatigue and of the mechanisms of the spread of air-borne infections, and other branches of medical science.

This linking up of nutrition and health with agriculture is a noteworthy example of the way in which provision for war-time needs is serving those of long-term policy or reconstruction after the War. The hospital services themselves provide yet another outstanding example; air warfare has already forced upon us a transformation of our medical services. The admirable analysis of the Emergency Hospital Scheme contained in the second P E P broadsheet, on "Hospitals in War Time", not only reviews the scheme in action, but also makes constructive proposals for the improvement of this highly centralized organization.

The first of these proposals is the development of the Emergency Hospital Scheme into a National Hospital Service. The estimates of expected casualties should be reviewed, but the State should continue to pay full treatment costs for Service cases and air-raid casualties, and also for all children, as well as residual costs for full-time civil defence workers, Home Guards, etc. A direct State subsidy to hospitals to maintain their working efficiency is proposed. Changes in central administration involve transforming the E.H.S. Division of the Ministry of Health into a National Hospital and Medical Services Division, and the Ministry would have to play a more positive part to ensure that hospital services everywhere are brought up to an adequate level for the needs of the whole population.

These proposals involve greater regional autonomy and co-ordination. They can only be carried out if the Ministry's regional staffs are strengthened and greater powers delegated to them. The regional and group officers must be carefully selected for administrative ability and be vigorously backed by the Ministry. Other proposals relate to the further development of services: for example, out-patient departments and specialist clinics at appropriate base hospitals, pædiatric services in all reception areas, regional courses on the structure of the E.H.S. and its experiences in action, on war surgery in general, on blood transfusion, poison gas, rehabilitation of the injured and the nursing of war wounds.

Finally, the broadsheet proposes machinery for the planned use of medical man-power, including the transformation of the Central Medical War Committee into a War Medical Service Committee, representing all the interests involved, to determine priorities, to allocate medical men to the various civilian and military services, and to plan their geographical distribution and full employment. Working through regional committees, incorporating the machinery of the existing local

medical war committees, which register local medical men for national service and recommend how they should be allocated, this proposal might not only facilitate the transference of private practitioners to correspond with the movements of population, but also assist in the use for civilians of medical men in the armed forces who are not fully utilized at present—a question already much discussed by practitioners and social workers and one which may soon become an urgent general question.

Since the broadsheet appeared the Government has announced the broad principles on which its post-war policy will be based. The partnership between the local authorities and the voluntary hospitals is accepted, not merely as the existing basis of the hospital services but as the necessary basis, supplemented by sufficient Government support to ensure that as soon as possible after the War appropriate treatment should be readily available to all in need of it through a comprehensive hospital service. The Government proposes to lay on the major local authorities the duty of securing, in co-operation with the voluntary agencies, the provision of hospital services, and that the service must be designed to serve areas substantially larger than those of individual local authorities, so as to avoid wasteful multiplication of equipment and accommodation. The Government also proposes to secure the provision of the more highly specialized services at teaching hospitals and other selected centres.

These proposals, though less detailed, are clearly in line with the general ideas underlying the recommendations of the P E P broadsheet. Both sets of proposals visualize the construction of the new hospital service on the experience of the past, and the synthesis of traditions and techniques, previously separate, in the service of a wider movement. Nowhere indeed are there wider possibilities in the building of a healthier social order than in this field of public health, if we but utilize aright the new knowledge and experience of nutrition and healing, of regional organization and administration which lie at our command as a result of research and development, in part through the impact of the War. Social habits, both of diet and of occupation, have been broken down, giving us immense opportunities of raising the whole standard of life and health, if we are ready to seize those opportunities after the War. Nor need we wait until after the War. As Lord Horder has reminded us, in this matter of food and fitness, health and education, child welfare and agriculture, we can begin now in the very service of our war effort.

WORLD ECONOMICS AFTER THE WAR

Economic Peace Aims: a Basis for Discussion
By Oswald Dutch. Pp. 280. (London: Edward Arnold and Co., 1941.) 12*s*. 6*d*. net.

MR. DUTCH begins his book with an excellent destructive account of the muddle which was made, especially from the economic point of view, of the settlement of European affairs after the War of 1914–18. This encourages the hope that he will be equally successful in making practical proposals for the settlement after this War. But this hope is disappointed. Mr. Dutch wavers continually between an almost Utopian optimism —as when he proposes that the world shall become practically a free trade area without any barriers in the way of free exchange within about a twelvemonth of the conclusion of hostilities—and a contrasting pessimism which causes him to harp on the dangers of over-production and the need for a universal system of quotas, which are somehow mysteriously to be prevented from operating in the same restrictive fashion as capitalist monopolies have by his own admission been operating in recent years. Again, Mr. Dutch is so haunted by the fear of totalitarianism in all its forms that he appears unable to recognize anything of value in the achievements of the Soviet Union, which he continually brackets with Nazi Germany and Fascist Italy as a horrible example of the destruction of every kind of human liberty.

Mr. Dutch is, in effect, an advocate of controlled capitalism as the instrument of post-war reconstruction over all the world. "The primary and most important fundamental for fixing the status of capital in a new economic plan must be that property remains untouched. There must be no capital levy, no expropriation, no breaking up of landed property, and no abolition of hereditary rights." In view of this sweeping statement it is not surprising to find that, in spite of his devotion to the cause of liberty, he has no hesitation in recommending the conscription of labour for the work of reconstruction. "It will be advisable not to demobilise these men [the armed forces, except those who have definite jobs to go back to] but to put them to work in groups, under army discipline but at full rates of pay." I fancy that, in all countries, the returning conscripts will have

something to say about this simple plan, especially if Mr. Dutch's views about the immunity of capital are carried into effect.

The truth is that Mr. Dutch very simply identifies democracy with capitalism. He recognizes that capitalism will need to accept a large element of State planning in the post-war world, but he assumes that ordinary men and women will be quite content to accept a military discipline that will compel them to work for controlled capitalism acting as the agent of public policy. "This work" [the work of reconstruction], he says, "will not of course be carried out by the State directly but by private firms commissioned by the State." Very possibly it will, but the human beings whom the State is to send to work for these private firms' profit will in that case be disposed to ask a good many questions to which Mr. Dutch neither provides nor attempts any answers.

For the rest, Mr. Dutch shares the projector's habit of specious particularity in prescribing measures for the post-war world. He is at home when he is neatly classifying things, and saying categorically that this and that will be done. But sometimes his particularity conceals a real confusion of mind. It is, for example, quite impossible to extract from his various statements any clear notion of the position which he expects Great Britain to occupy in the economic or political structure of post-war Europe. Sometimes it appears that Great Britain is to be an integral part of a unified European system, and at others that Great Britain, linked to the British Empire, is to stand outside, but related to, a Continental system in much the same way as the United States. He recognizes clearly the part which the United States will be called upon to play, not only in the immediate tasks of relief but also in the long-term reconstruction and development of the European continent and of the backward countries of Asia and the rest of the world. But in relation to Great Britain he shows a marked desire both to eat his cake and to have it, by treating Great Britain both as a part of the European system and as a partner with the United States in reconstructing a European system to which she will not completely belong. "Resolutions taken by the Parliament and Government of the Commonwealth will be restricted to Continental affairs and Great Br tain will be excluded from the territorial sovereignty of the Commonwealth Government. Great Britain will have to share in much of the responsibility for Continental affairs, especially in matters of defence, finance, and economic problems. On the other hand, the European Commonwealth will have no responsibility for British affairs." This, and the chapter from which it is taken, seem to me merely muddled. I have no conception of what Mr. Dutch really means.

I do, however, understand what he means when he writes that "the masses of the peoples must be transferred from war to peace work at once without giving them time to organize themselves elsewhere or to carry out any extremist plans". I think Mr. Dutch's conception of democracy is that of a society in which, on one hand, there is "no capital levy, no expropriation, no breaking up of landed property, and no abolition of hereditary rights", and on the other hand, the peoples are compulsorily driven to labour "without giving them time to organize themselves elsewhere or to carry out any extremist plans". This is not my conception of democracy; and I find it, to speak plainly, quite infuriating in one who appeals to his readers in democracy's name. I suppose Mr. Dutch believes himself to be a democrat, and is not pulling his readers' legs. But I sincerely hope no one will take him as a guide to the foundation of our economic peace aims, and at the same time greatly fear that many people will; for he presents just the sort of muddled eclecticism which is calculated to appeal to those who wish to believe that the new world can be at once altogether different from the old and a secure repository of all the ancient values which they personally would like to preserve.

G. D. H. COLE.

A REVIEW OF THE ALGÆ

An Introduction to the Study of Algæ
By V. J. Chapman. Pp. x+387. (Cambridge: At the University Press, 1941.) 18*s*. net.

THERE has long been a need for a short general account of the Algæ, for the various works published during recent years are either detailed treatments, often dealing only with certain aspects, or specialized taxonomic works. The book under review aims at supplying this need and endeavours to deal briefly with the study of Algæ from every point of view. The task that the author has set himself is no light one, and for its successful accomplishment both considerable experience and a judicious handling of the subject-matter are requisite. Despite diverse defects, Dr. Chapman's book will undoubtedly prove of value to those wishing to obtain an outline knowledge of the range of form and reproduction and of the manifold roles that Algæ play in Nature. The author has shown great industry in assembling the wide range of

matter that is covered, but one cannot help feeling at the outset that he has detracted seriously from the value of his work by endeavouring to include too much and by the manner of presentation, which lacks continuity. It is difficult at various points to get away from the impression of rather hasty compilation, and diverse sections would have profited from a more carefully considered and balanced treatment.

Rather more than two thirds of the book is taken up by the taxonomic and morphological matter, and here the Chlorophyceæ and Phæophyceæ occupy the bulk of the space. The sections on Cyanophyceæ, Xanthophyceæ and Rhodophyceæ are brief, while all other classes receive little more than mention. In each main section, after a short introduction, a series of 'types' is described. Apart from the question whether such separate consideration of genera is the most suitable method of introducing the reader to an acquaintance with the Algæ, too many examples are often selected. This has the disadvantage of confusing the picture, the more so as individual descriptions are commonly so inadequate that one may doubt the value of their inclusion. As examples, Chordaria, Elachista and Corallina may be mentioned, while the account of Sporochnus gives no conception at all of the structure of this remarkable form, so fully studied by Kuckuck and Sauvageau. The choice of 'types' does not always appear to be very appropriate. Among the true desmids, for example, the only genus considered is Closterium, which is divergent in various respects. It is difficult to understand why Martensia is brought in on p. 230, when the multinucleate character of the tetraspore mother-cell is equally well shown by the British *Nitophyllum punctatum*. Nemalion is referred to at the end of the description of Batrachospermum because of the division of the spermatium-nucleus which is also recorded in the latter, while more important features, such as the fusions in the carpogonial branch of Nemalion, are not mentioned.

The subject-matter is in general up to date, but if the author had delved rather more deeply into the Continental literature, he would have avoided several misstatements or omissions. Thus, the unilocular sporangia of *Ectocarpus virescens* (p. 134) were described by Sauvageau in 1933, and Papenfuss described the gametophytes of Spermatochnus (p. 148) in 1935. Under Sphacelaria prominence is given to the rather inconclusive work of Clint, while that of Papenfuss which, together with that of Schreiber on Cladostephus (1931), sheds considerable light on the nature of the life-cycle in Sphacelariales is afforded a rather casual mention. A perusal of Nienburg's work (1913) would have contributed to a clearer presentation of the development of the conceptacle in Fucales. The account of cell-structure of Cyanophyceæ is scarcely in accord with the present state of our knowledge. A number of erroneous statements, for example, the reference to Phacotus as a colourless form, that relating to the orientation of the flagella in Dinophyceæ, and the development of the cystocarp-wall in Polysiphonia, should have been avoided. There are other inaccuracies. For example, red snow (p. 33) is due to a species of Chlamydomonas and not of Sphærella, as was shown long ago by Wille, the 'trumpet-hyphæ' of Laminariales are almost certainly for the most part neither connecting threads nor hyphæ, while the account of the mature Thalassiophyllum plant accords ill with the familiar figure of Postels and Ruprecht.

Statements are made in various parts of the book that appear to lack any sound foundation; examples are the suggestion of homoplasy between Merismopedia and Prasiola, that the original centre of distribution of Laminariales was in the North Pacific, and that there is an affinity between Trentepohlia and Phæophyceæ. The chapter on reproduction and evolution is in my opinion a definite backward step, and the matter is presented in such a form that the student will find difficulty in following it. A scheme such as that given on p. 261 has no support whatever in fact and is contrary to all modern teaching, while the value of phylogenetic trees like that on p. 262 may be questioned. The final chapters dealing with physiology and ecology contain a considerable amount of useful though not very thoroughly digested matter. The account is, moreover, marred by too much tabular presentation, and the treatment is in part rather one-sided. Why, for example, should a range of salt-marshes be considered, while the account of lake communities is restricted to Windermere? Why should freshwater and marine plankton be almost entirely ignored and yet several pages given to a tabulation of various classifications of life-form among the Algæ?

The brief citations of literature at the end of each chapter are perhaps intentionally rather one-sided, since reference is often made mainly to British and American papers. A considerable number that are included are, however, rather paltry and might with advantage have been omitted to make place for others of greater importance. One is surprised, for example, to find no mention of Killian's paper on Laminariales, of Sauvageau's classical memoir on Sphacelariales, and of Kylin's more recent contributions to Floridean morphology. The copious illustrations occasionally suffer from too much reduction or from crowding.

F. E. FRITSCH.

VEGETABLE PRODUCTION IN THE TROPICS

Vegetable Gardening in Malaya

By J. N. Milsum and D. H. Grist. (Malayan Planting Manual, No. 3.) Pp. xviii+215+52 plates. (Kuala Lumpur: Department of Agriculture, 1941.) 2 dollars.

IN recent years British Colonial policy has been largely directed to matters of nutrition, and the health and well-being of the native inhabitants have been matters of particular concern. In many Colonies the development of export crops had, for long, been the main interest, and such research and experiments as have been undertaken were largely devoted to these crops. Latterly, however, the need for the investigation of the food crops of the people has received increased attention, and new discoveries in the realms of human nutrition have brought to light the unbalanced ration on which so many of the people have had to subsist, and more particularly the need for the increased consumption of those foods containing the so-called 'protective elements'.

The book under review deals with vegetable gardening in Malaya and is a sequel to two previous publications on the same subject published by the Department of Agriculture of the Straits Settlements and Federated Malay States. The senior author of this edition has been associated with all three publications. This one includes and brings up to date much of the information incorporated in the previous volumes.

The present book is a complete compendium of vegetable gardening in Malaya. It includes detailed accounts of the most important of the native vegetables grown, and also some of the newer introductions of foreign origin. So many of the gardening books of the tropics have included the cultivation of fruits and flowers, that they are somewhat unwieldy, and as a result the section devoted to vegetables has often been too scanty. A similar mistake has not been made in this instance where the work is confined strictly to the cultivation of vegetables. Useful chapters describe the methods of preparing the land, and the common insect pests and diseases and ways of controlling them. There is also an account of the vitamin contents of the different kinds of vegetables, written in popular language, which is a novel and welcome addition. The description of the cultivation of European vegetables in the highland area is all too brief and might with advantage have been expanded. These high plateaux in the wet tropics present particular difficulties. The temperature is cool enough to suit vegetables from the temperate regions, but the heavy rainfall and the high humidity make matters difficult, and doubtless special varieties will need to be bred to meet these special conditions. These difficulties appear to have been overcome to some extent in the Cameron Highlands by raising the plants under glass-topped frames. An account is given of this method, which may well be worthy of trial in other similar regions in the tropics, but one is inclined to wonder whether the capital cost of such installations might not prove too heavy.

The chapters on economics are of particular interest. A comparison with the neighbouring island of Java shows that the latter country with a teeming population of more than fifty millions is able not only to supply its own needs, but also to export vegetable products to Malaya to the value of half a million dollars. Malaya is in fact largely dependent on outside sources of supply and obtains large quantities of vegetables from China and India. One of the reasons for this state of affairs is the comparatively infertile nature of the soils. In Java the soils are rich, being derived from rocks of modern volcanic origin, but in Malaya, the underlying strata belong to geologically ancient formations and the soils have been leached of their mineral salts by hundreds of years of tropical rainfall. Another contributing factor is the different character of the population. In Java every person is an agriculturist and skilled in the cultivation of the soil, but in Malaya this is not the case, and the Malay was, until recently, accustomed to seek his livelihood on the sea or in the jungle, and did not take kindly to the settled life of a farmer. It is for this reason that we find that even at the present time nearly all the vegetables produced in Malaya are grown by the Chinese, who have settled in the country in comparatively recent times. The Chinaman is the gardener *par excellence* of the tropics. One may not admire all his methods from the strictly hygienic point of view, but he does produce the goods. Further, as is clearly brought out in this book, he thoroughly understands the art of watering and the necessity for abundant supplies of humus and organic fertilizers. He invariably adopts mixed farming methods to supply these needs, and for this reason he combines the keeping of pigs and poultry with his gardening, and is able to convert most unpromising sites, such as the tailings of a tin mine, into flourishing market

gardens. He imports much of his seed from China, and there is no doubt that the varieties of certain cruciferous, leguminous and salad plants which he grows—and they are numerous—would well repay the critical survey of seedsmen from Western countries. It would be fairly safe to prophecy that such a detailed examination would result in the discovery of additions to our present list of cultivated vegetables, which would be of great value to the plant breeder.

Efforts are now being made by the Department of Agriculture to persuade the Malays to emulate the example set by the Chinese. The latter seem to have the trade for the supply of vegetables in bulk to the towns in their hands, but there is no reason why the Malay cultivator and the estates should not do more towards growing sufficient for their own requirements. The efforts that are being made in this direction are well described, and the drive is being stimulated by existing war-time conditions, which have resulted in a shortage of shipping and thus of imports.

The book is illustrated with photographs of the more typical vegetables and is well worthy of the study of all people interested in tropical gardening.

GEOFFREY EVANS.

THE NEW PHARMACOLOGY

The Pharmacological Basis of Therapeutics
A Textbook of Pharmacology, Toxicology and Therapeutics for Physicians and Medical Students. By Prof. Louis Goodman and Prof. Alfred Gilman. Pp. xiii+1383. (New York: The Macmillan Company, 1941.) 50*s*. net.

In the past, most important pharmacological discoveries have been made in German universities and German commercial laboratories, but in recent years the work of American pharmacologists has been growing rapidly in importance. "The Pharmacological Basis of Therapeutics", by Profs. Goodman and Gilman of Yale, is a valuable review of this American work.

The authors must be warmly congratulated on this remarkable book. It is written from the clinical point of view; experiments on man are described more fully than experiments on animals, the results of which are given without detailed discussion, so that the book is a work of reference for the intelligent medical practitioner rather than an exposition of the methods which have led to such remarkable advances in pharmacology in recent years. In this respect the book resembles many recent text-books of pharmacology, which have tended to concentrate on the applications of the results to man. This tendency is in many ways a good one, but there is a danger that it may go too far, and that the student may never learn that pharmacology is a living experimental science, which has had great practical effects.

Most medical students will find this book too long, but it will be very valuable for teachers and experimentalists. It contains thousands of references to recent work, a large proportion of them to papers published in 1940. It opens with 100 pages on anæsthetics, and there are 180 pages on cholinergic and adrenergic nerves, more than 100 pages on sulphanilamide and related drugs, 88 pages on hormones and 60 pages on vitamins, with equally complete sections on other branches of pharmacology.

All this wealth of information is apt to have a humiliating effect on anyone who has tried to keep abreast of pharmacological literature, and to stimulate a search for omissions. The clue to success in such a search lies in the fact that the European literature has been less well covered than the American literature. For example, in the section dealing with emetin cathartics, it is stated that the time required for the drugs to traverse the small intestine, and the necessity for a chemical liberation of the active principle, delay the cathartic action, but there is no discussion of the work of Straub, which showed that delay in the small intestine played no part in the time of action of senna, which was not affected by tying the small intestine so that the drug could only act through the blood stream.

The release of histamine in anaphylaxis is dismissed as if it were a dubious speculation rather than a well-proved fact, while the release of histamine by the exposure of sensitive individuals to cold is thought to be established by the isolated observation that an acid gastric juice is secreted.

The section on sympathomimetic drugs contains no mention of perovitin (or methedrine) which has aroused interest in Great Britain because it has been said to have been used to increase the endurance of German parachute troops.

In spite of a few such omissions, the text as a whole is very full and up to date, and gives a very fair account of controversies still raging. It is the kind of work that might have been the fruit of the collaboration of a team of authors, and it is difficult to think how two men did it.

J. H. GADDUM.

The Physical Examination of Metals

By Dr. Bruce Chalmers and Dr. A. G. Quarrell. Vol. 2: Electrical Methods. Pp. viii+280+8 plates. (London: Edward Arnold and Co., 1941.) 20*s*. net.

IN Vol. 1 (reviewed in NATURE, 145, 660; 1940), Dr. Chalmers described optical methods of metallurgical investigation. In the present volume, he unites with Dr. Quarrell, a pioneer in the development of electron diffraction research in metallography, to deal with electrical methods, thus completing a work which will be a boon to the research worker and an indispensable part of students' reading.

The scope of vol. 2 is reviewed in its first chapter. It is logically planned, commencing with magnetic properties and their measurements. Electric measurements and thermo-electric effects are then discussed. X-ray diffraction technique, as applied to metallurgy, is then dealt with and electron diffraction methods follow. The present position of electron microscopy is then examined. The final chapter deals briefly with radiography. Appendixes are devoted to electrolytic polishing and X-ray crystallographic data.

This book successfully combines theoretical treatment with practical outlook. The authors have certainly succeeded in their attempt "to indicate the scope and limitations of the various methods . . . by reference to successful applications". One application, hitherto unpublished, is a very pretty microthermal analysis (p. 108), for which Dr. Chalmers managed to do without any gramophone needles.

Perhaps because it is regarded as engineering rather than metallurgy, stress analysis is not dealt with in the discussion of X-ray diffraction methods.

H. W. G. H.

Modern Assembly Processes

Their Development and Control. By J. L. Miller. Pp. xii+168+28 plates. (London: Chapman and Hall, Ltd., 1941.) 13*s*. 6*d*. net.

IT is possibly strange that engineers have had to wait so long for a book dealing specifically with jointing methods used in the large-scale production of small parts. So far as Great Britain is concerned, it is probable that everybody has waited for Mr. Miller to write it. Those readers who have not the good fortune to know the author personally, will learn from this book that he is a first-class engineer of very long practical experience and gifted with the intelligent curiosity and enthusiasm which most people lose when they gain years of discretion. Those who do know him will enjoy meeting him again in these pages, packed with common sense, and will take particular pleasure in the simple logic with which each point is explained.

The processes dealt with are riveting, soft soldering, hard soldering and brazing, hydrogen furnace brazing, pressure and shrinkage fits, fusion welding by gas and arc methods and electrical resistance welding. The advantages and limitations of each method of jointing are clearly stated and the fundamental principles, on which a choice should be based, are admirably stressed. The chapters on hydrogen furnace brazing and projection welding are unique, since the author has had unique experience in developing and applying these processes; but there are few chapters in which the most up-to-date engineer will not find something useful, and the wisdom of Chapter 14, "Testing, Inspection and Trouble Hunting", is worth every penny of the book's purchase price.

Polynesian Paradise

An Elaborated Travel Journal, based on Ethnological Facts. By Donald Sloan. Pp. 288+15 plates. (London: Robert Hale, Ltd., 1941.) 12*s*. 6*d*. net.

THIS book is a departure from the usual type of story from the South Seas in that it contains quite a lot of information that will interest an anthropologist. The author lived for several months on Manu'au, an isolated group of three volcanic islands inhabited by Polynesians of Samoan stock. These islands are off the usual routes and their isolation has been jealously guarded by the United States of America, to whom they belong, in order to preserve their integrity. This is the more easily done as the Manu'ans themselves are a conservative race and cling to their old ways of life.

By living among them as he did, the author was able to enter freely into their daily life, and he obviously made good use of his opportunities. As a personal guest of the chief he was present, and partook of, all the important feasts and ceremonies, including those for the burial of the chief and the marriage of the village virgin. He gives full accounts of these as well as of the daily life of these unsophisticated people, with whom he was evidently on excellent terms. While there he learned, among other things, to fight with and kill a shark single-handed and armed only with a sharp knife: dealing thus with a seven-foot man-eater provides a truly Homeric contest.

Natives such as those Manu'ans who dwell in isolated parts and live out their lives in the old traditional way are always an interesting study, and although this book is perhaps more adventurous than deeply scientific, it may be none the worse for that as it is likely to interest a wider circle of readers in an extremely important study—that of the unspoilt native peoples.

Introductory Foods

By Oseo Hughes. Pp. vii+522. (New York: The Macmillan Company, 1940.) 12*s*. 6*d*. net.

THIS book will be regarded as throwing interesting light on the impact of nutritional science on cookery practice in the United States. It shows how the American housewife has become 'food-conscious' and 'vitamin-conscious', and why she has been diverted from the straight and honest path of Mrs. Glasse and Mrs. Beeton. The author has given quite a good scientific background to the hundred and one cooking problems he discusses. Vitamins, viscosity, surface tension, denaturation, crystal form are only a few of the scientific problems dealt with.

FOOD FROM THE GARDEN

By DR. H. V. TAYLOR
MINISTRY OF AGRICULTURE
AND
DR. J. C. DRUMMOND AND DR. M. PYKE
MINISTRY OF FOOD

IN peace-time, gardening was merely a hobby to a great many people. In consequence it was common to have a superabundance of vegetables in the summer and insufficient in the winter. Very few people before the War gave any thought to the food value of the crops they grew in their gardens. Nowadays, however, it is essential that vegetables should be produced in a systematic sequence throughout the year and that those vegetables should be grown which will provide in greatest abundance the food constituents most needed in the war-time diet.

The method of cropping described in 1939 by the Ministry of Agriculture in Bulletin No. 1, "Food from the Garden", was designed to fulfil these requirements. The Bulletin contained a cropping plan of the area to be devoted to each crop, the time of sowing and the period of use of each crop. Gardens and allotments were planted in this way during 1940 in most towns of England and Wales. Ninety-eight gardens and allotments, each of ten perches in size, planted in this way were selected and records were made daily of the weight of the crops and the time of gathering. From the complete records set out in the accompanying tables it will be seen that the yield averaged for all these gardens for the year was 411 lb. of potatoes and 1,085 lb. of other vegetables.

Although potatoes and some other vegetables can be stored for considerable periods, it is essential for any plan to be satisfactory in war-time that it ensures a continuous supply of fresh vegetables throughout the year and especially during the winter period. In each of the four quarters of the year at least a dozen different vegetables were available from the planned allotments. In the summer period, for example, there were broad beans, runner beans and dwarf beans, cauliflowers, carrots, peas, lettuce, spinach and turnips. The weekly supply of vegetables other than potatoes during each season was approximately that shown as follows:

	Gross weight lb.	Edible weight lb.
Summer	19	12·4
Autumn	19	14·8
Winter	26	19·7
Spring	17	11·2

From these figures it can be seen that not only has the continuous weekly supply throughout the year been achieved, but also that an increased supply is available during the winter when it is most needed.

When the Ministry of Agriculture cropping plan was devised it was known that the field supplies of potatoes would be more than sufficient. In consequence the garden and allotment crop was planned only to provide the household with potatoes until Christmas. In actual fact the gardens from which records were taken gave 82 lb. during the summer period and 330 lb. during the autumn months. This represented a weekly supply of 6 lb. of new potatoes during July–September and 24 lb. a week of main crop potatoes during October – Christmas.

According to Orr and Lubbock[1] the amount of vegetables eaten per week during the period 1937–1939 was 4·2 lb. of potatoes and 1·66 lb. of other vegetables. These authors recommended that the desirable consumption during war-time of veget-

TABLE 1.
CROPS IN SEASON FROM GARDENS AND ALLOTMENTS 300 SQ. YARDS IN SIZE.

Vegetable.	Weight in lb.				Total Crop
	Summer	Autumn	Winter	Spring	
Broccoli, sprouting...				23	23
Brussels sprouts ...		18	25		43
Cabbage	5	50	50	53	158
Kale			23		23
Lettuce	27	9		18	54
Savoys			58		58
Spinach	10	10		10	30
Turnip Tops ...				6	6
Beans, Broad ...	21				21
Beans, Dwarf ...	20				20
Beans, Runner ...	34				34
Beans, Haricot ...		1½	1½		3
Peas	25			25	50
Potatoes, New ...	82				82
Potatoes, Old ...	55	137	137		320
Beet	19	19	19		57
Carrots, Young ...				17	17
Carrots, Old ...	27	27	27	10	91
Parsnip		27	40		67
Radish				12	12
Swedes		8	27		35
Turnips		27	27		54
Leeks			12	24	36
Onions, Spring ...				9	9
Onions	15	15	15	15	60
Shallots	1½	1½	1½	1½	6
Marrow	17	17	17		51
Cauliflower	15	16			31
Celery	6	7			13
Tomato	10	5			15
Parsley & Herbs ...	1	1	1	1	4
Rhubarb				4	4
Total Crop ...	390½	396	481	228½	1,496
Totals, less Potatoes	253½	259	342	228½	
No. of persons at 2·6 lb. vegetables per week	7·5	7·7	10·1	6·7	

ables other than potatoes should be 2·6 lb. a week. On this basis the vegetable supply from each of the ninety-eight gardens was sufficient for a family of five people for the whole year and in each season of the year.

Nutritive Values

Although potatoes supply a substantial proportion of carbohydrates, and thus of calories, to the diet and they and other vegetables provide a certain amount of protein, vegetables are primarily of importance for their 'protective' value, that is to say, the vitamins and mineral salts contained in them.

For an adult a good daily allowance of vitamin A is about 5,000 international units and of vitamin C about 50 mgm. These are the two vitamins which vegetables can primarily supply. Vitamin B_1 is derived from wheatmeal bread and other cereals and to a less degree from potatoes, pork and meat, although green vegetables make some contribution.

It will be seen from the accompanying tables that the vegetables produced according to the Ministry of Agriculture cropping scheme provide the full dietary needs of vitamin C throughout the year for from 8 to 12 people. Considerable losses due to wastage, cooking and other causes may be expected, so that it would be conservative to consider this equivalent to the true requirement of a family of 4 or 5 people. This is a most valuable contribution to the national diet and one which can only be achieved by planning vegetable production with a clear appreciation of the object in view. This contribution of vitamin C made to the diet by vegetables is particularly noteworthy at a time when fruit is difficult to obtain. The amount of vitamin A provided in the form of carotenoid precursors, mainly β-carotene, while not so ample as that of vitamin C, is nevertheless a most substantial proportion of the family requirement. The loss of vitamin A in cooking is very much less than that of vitamin C.

Examination of Table 2 in detail shows the contribution made by each vegetable. For example, carrots, which are available throughout the year, provide the major proportion of vitamin A. It would therefore be inadmissible to substitute any other crop for them. Similarly, savoys, which are available in the period January–March, maintain the supply of vitamin C at that time. The amounts of such minor crops as beets, shallots or turnips may be varied to some extent according to taste, but alteration in the quantities of winter greens, for example, and particularly carrots, will weaken considerably the whole plan of a continuous supply of 'protective' nutrients.

Beside their primary role in the diet as sources

TABLE 2.

QUANTITIES OF VITAMINS A AND C IN CROPS.

Crop	Average Vit. A. (I.U. per 100g.)*	Average Vit. C. (mgm. per 100 g.)	Summer		Autumn		Winter		Spring	
			Vit. A. I.U.	Vit. C. mgm.	Vit. A. I.U.	Vit. C. mgm.	Vit. A. I.U.	Vit. C. mgm.	Vit. A. I.U.	Vit. C. mgm.
Broccoli, Sprouting	300	65							31,000	6,700
Brussels Sprouts	300	65			24,000	5,200	34,000	7,200		
Spring Cabbage	300	65							71,000	15,400
Winter Cabbage	300	65	7,000	1,500	67,000	14,600	67,000	14,600		
Kale	300	65					31,000	6,700		
Lettuce	300	65	36,000	7,600	12,000	2,600			24,000	5,200
Savoys	300	65					78,000	16,800		
Spinach	300	65	13,000	2,900	13,000	2,900			13,000	2,900
Turnip Tops	300	65							8,000	1,700
Broad Beans	0	0								
Dwarf Beans	0	0								
Runner Beans	300	65	46,000	9,900						
Haricot	0	0								
Peas	300	65	33,000	7,200					33,000	7,200
Potatoes, New	0	12		4,400						
Potatoes, Old	0	6		1,500		3,700		3,700		
Beet	0	15		1,300		1,300		1,300		
Carrots, Young	6,700	4							570,000	300
Carrots, Main	6,700	4	810,000	500	810,000	500	810,000	500	300,000	200
Parsnip	0	15				1,800		2,700		
Radish	0	15								800
Swedes	0	15				500		1,800		
Turnips	0	15				1,800		1,800		
Leeks	0	16						900		1,800
Onions, Spring	300	16							12,000	600
Onions, Bulb	0	16		1,100		1,100		1,100		1,100
Shallots	300	16	2,000	100	2,000	100	2,000	100	2,000	100
Marrow	0	4		300		300		300		
Cauliflower	0	65		4,400		4,600				
Celery	0	15		400		500				
Tomato	1,000	25	45,000	1,100	23,000	600				
Parsley	300	65	1,000	300	1,000	300	1,000	300	1,000	300
Rhubarb	0									
Others	0									
Quarterly Total			993,000	44,500	952,000	42,400	1.023,000	59,800	1,065,000*	44,300
Number of people for which this is the *full* daily requirement			2	9	2	8	2	12	2	9

* Figures based on carotene analyses of vegetable groups.

of vitamins A and C, the vegetables produced from an allotment provide a useful percentage of the mineral elements in which war-time food is likely to be deficient. Calcium particularly, which is important for growth and the structure of the bones in children and for adult well-being, is present in substantial amounts in green vegetables such as kale, sprouting broccoli and turnip tops, and in appreciable quantities in many other vegetables.

Conclusion

The results of a critical assessment of the produce grown during 1940 on ninety-eight gardens and allotments show that, under the system of cropping recommended by the Ministry of Agriculture, a fairly even supply of vegetables is secured, with the larger quantities being available during the winter months. These vegetables can probably supply the vitamin C requirements and a substantial proportion of the needs for vitamin A for a family of five people throughout the year, taking into consideration losses due to cooking and other causes. In addition, they provide substantial contributions of other vitamins and of minerals, particularly calcium and iron. The importance of cropping gardens and allotments in this way cannot, therefore, be stressed too strongly.

[1] "Feeding the People in War-Time", by Sir John Orr and David Lubbock, Macmillan (1940).

APPLICATIONS OF PARTICLE SIZE ANALYSIS

By Dr. E. G. Richardson
King's College, Newcastle-upon-Tyne

Many methods are available for the delineation of the size-frequency curve of a substance in amorphous form, but most of those in current use are adaptations of the microscope or of sedimentation technique. Each of these has certain disadvantages. The microscope—whether it employs a beam of light or a beam of electrons—demands the careful selection of a representative sample, and much tedious measurement of the cross-section of individuals, setting aside problems of optical resolution and distortion. Rather similar criticism applies to the X-ray method, though this seems only to have been applied to a system having particles of nearly equal size. A method in which the powder is allowed to settle in a suitable fluid medium, either in a gravitational or centrifugal field, or alternatively is held stationary or driven against such a field by a suitable upward fluid current, on the other hand, demands an assumption of Stokes' Law or one of its recent modifications, and also requires that the powder is not so concentrated in suspension that neighbouring particles interfere with each other's movements, and that temperature gradients may not give rise to convection currents. It is also necessary to see that the estimation of the 'weight of a sample'—using the words in a statistical and not in a literary sense—which is taken from time to time as the powder settles does not spoil the course of the sedimentation. Probably, the 'photo-extinction method', in which the weight of a sample is estimated by casting a beam of light athwart the settling tank to fall on a photo-electric cell, is the most accurate as well as the most convenient of these, particularly as it will work with quite small amounts of the powder.

It is not, however, the purpose of this article to discuss the methods themselves[1], but rather to direct attention to the increasing number of applications of the technique in the spheres of applied physics and chemistry.

Applications to Powders

One of the difficulties that trouble the employer of this technique is to ensure that the degree of dispersion which exists in the sample chosen for analysis persists during the examination itself. For example, if particle-size analysis is chosen as one of the fundamental physical factors in describing soil properties, as it undoubtedly should be, how can the state of aggregation and relative positions of the grains be preserved during their transfer to the microscope or sedimentation tank? Indeed, since in either apparatus the particles must be separated or diluted to a certain extent, the purist would say that the analysis ought only to be done *in situ*, which in the present state of the technique is impossible.

For some materials, sedimentation at low concentration is favoured, with the addition of a reagent like ethylene glycol to the liquid, into which the powder is vigorously stirred, short of causing actual abrasion. If it is intended to study the effect of such deflocculating agents on the results as well as to obtain a set of results representative of the original sample, the unfortunate operator has indeed been set a difficult problem.

It is evident that each industry must work out its own dispersion technique in international collaboration if results in different laboratories are to be comparable, though the agreed results may still not represent the powder in its natural state.

Particle-size analysis is constantly being used to determine the efficiency of grinding and milling processes and to estimate to what extent equality of fineness may be produced in similar mills when used by different operatives or in different factories. The problem presents itself as that of deciding how a certain property depends on the granularity of the powder or material in which it is incorporated, and then of finding to what extent a specified degree of fineness can be reproduced in practice.

Thus in the baking industry, particle size is one of the chief features which discriminate those flours which are suitable for cake-making from those which will form a good bread dough. In the accompanying table are shown the results of some analyses of different types of commercial flour. It will be noticed that there is not much difference in the two commercial bakers' flours, but the flour made from the Irish wheat, being softer to the touch, has a greater percentage of fine particles. On the other hand, the strong imported flour from Canada tends in the other direction and has more large grains than the British-milled commercial flour. The speciality cake flours are all finely ground, but there are differences between them, those with the maximum of fine particles being found most useful for special cake processes[2].

PARTICLE-SIZE ANALYSES OF COMMERCIAL FLOURS.

Sample	Percentage corresponding to size group (in microns)								
	105–95	95–85	85–75	75–65	65–55	55–45	45–35	35–25	25–15
Commercial bakers' flour .	3	6	9	10	12	12	11	18	19
Irish flour .	5	4	4	3	4	6	10	19	45
Imported Canadian flour .	3	7	11	10	11	12	12	18	16
Cake flour (milled in England) .	3	3	4	5	4	4	11	19	47
Cake flour (milled in Canada) .	0	0	0	0	2	6	12	25	55

Occasionally, there seems to be a critical size which is most effective in a given process. A specific size is often mentioned in connexion with the dust problem in mines, whether as causing explosions or in diagnosing the cause of miners' silicosis. Pigment colours reach a maximum brilliance for a certain grain size probably associated with the wave-length of the light absorbed or reflected. On the other hand, certain light-influencing factors such as the brilliance of fluorescence in phosphor powders continuously increase as the particles causing it get smaller, apparently because on a given covered area the total surface of the exposed grains increases as they get smaller[3].

In those cases where the physical property which it is desired to influence depends on pore space, the size of the units which make up the texture of the material is equally a determining factor. The insulating plasters used as acoustic absorbents form an example. For a given total volume of grains in contact, the most open structure is obtained by securing that they are of uniform size. On the other hand, the concrete industry looks for a polydisperse mix to get a better conglomerate. These two extreme types of distribution curve are readily resolved in a sedimentation apparatus.

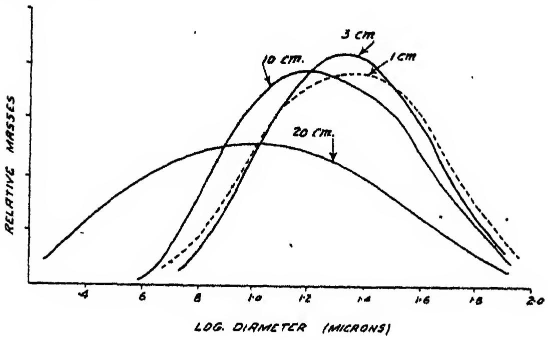
APPLICATIONS TO LIQUID PASTES AND SUSPENSIONS

It is well known that many liquid suspensions show anomalous flow behaviour, so that it becomes difficult to compare their viscosities unless measurements are made at equal shearing rates. There is often the added complication of hysteresis and other memorials of the previous history of the suspension. Nevertheless, it is generally found that viscosity rises as the aggregates break down. In monodisperse systems certainly, fine particles in themselves promote high viscosity, but many factors may obscure this effect, since the addition of coarser grains and the noted effects of thixotropy —reversible sol-gel transformation—and electrokinetic potentials on the state of aggregation may influence the flow behaviour of the suspension. When the grains are in the main large but are interspersed with very small, albeit, colloidal particles, the colloidal filling seems to act as an effective lubricant. In this way a stubborn soil becomes easy to plough and an erstwhile firm sand is turned into a quicksand. Such suspensions form valuable muds for oiling the drilling tool during the excavation of a bore hole. The phenomenon is usually explained by saying that the colloidal adulterant confers thixotropic properties on the specimen, whereby it is easily made to flow under a sufficient pressure, but partially 'sets' when the pressure is released.

By a similar process, fine particles confer cohesion on a modelling clay, and allow a cast to fit the mould more perfectly while not preventing it from being shaped under manual pressure.

Pigments in a liquid medium present similar light-dispersing characteristics in the paste form to those in the dry state. In addition, the manufacture of a liquid paint involves considerations of brushing and wetting properties which are again largely a question of granularity. The paints with finer pigments have better covering

power, which means that less paint will be required per square inch of that colour which has the greater specific surface. It has also been suggested that one could discriminate in this fashion between a medium which is a wetting agent—one that lowers the surface tension of water without altering the state of aggregation—and a true dispersoid which not only increases the number of fine particles at the expense of the aggregates but also imparts resistance to flocculation, an important factor in the conferment of good brushing or spraying properties in paints[4,5].



An interesting case in which two desiderata require size-frequency curves having peaks at opposite ends of the granularity range is to be found in the spinning of rayon. To control lustre the manufacturer adds titanium oxide in amorphous form to the cellulose acetate before it is spun. If this powder is too coarse, the jets from which the mixture is squirted become choked. On the other hand, the presence of fine particles raises the viscosity (*vide supra*) and involves greater pressure to force the rayon through the spinnerets.

APPLICATIONS IN NATURAL PHENOMENA

Recently, useful information has been acquired from measurements of the granularity of sediments put down by natural agencies such as winds and rivers. Sometimes these studies are made during the actual process of silt transport and deposition in rivers in spate or during desert storms[6,7], a field in which much still remains to be done in correlating the scale of turbulence to the silt-carrying propensities of the flow, which varies with the mean size of grain involved and the size-frequency distribution in a way not properly understood.

In fluid motions over a rough surface, it is the size of the rugosities which determine the character of the flow. This has been brought out by experiments in which a uniform sand has been glued to a smooth board set edgewise to the stream while its hydrodynamic resistance is determined. If, however, the sand is free to move, it will be transported whenever the velocity gradient at the boundary exceeds a critical value and redeposited at a lower critical value, which can be determined for each grain size. In mixed sands, these critical values are less certain, but their significance from the point of view of natural phenomena like the raising of desert storms or of the silting up of river estuaries is obvious.

Some preliminary work has been done on the analysis of cores drawn from lake beds, using an apparatus described in an earlier issue of NATURE[8]. These cores consist of recent deposits of semi-liquid mud overlying more compact stratified layers of clay in which fine and coarse particles often alternate, representing successive climatic stages in the history of the lake.

The accompanying figure represents analyses into size-frequency curves of the upper layers of the bed of Esthwaite Water, Lancs, in which only recent depositions are represented in the graphs for various depths. The whole extract is loosely compact and semi-fluid. The shifting of the mean towards finer particle size as the depth of sampling increases may be the result of chemical and bacteriological action breaking down the aggregates, which are formed of silt and organic detritus deposited on the lake bed in the absence of circulating currents, or it may mean no more than that the fine grains during the natural process of sedimentation penetrate through the interstices between the larger crumbs in the ooze until brought to a standstill lower down. The change in mean size goes rapidly at first with depth and then more slowly; in fact, a good straight line is obtained by plotting the logarithm of the most frequent size in the curves shown on the figure against the depth. A similar law is not, however, found for the hardened cores representing historical deposits. Bands of colour in the core and sudden changes in size-frequency distribution probably represent geological catastrophes in the bed formation or of the seasonal inflow of silt from rivers in spate.

It must be appreciated that many of the applications here outlined are in the early stages of their development, but it is hoped that sufficient examples have been given to show that the accurate measurement of granularity will be increasingly used to supply data without which the exploration of many phenomena, both in the laboratory and in the field, will be incomplete.

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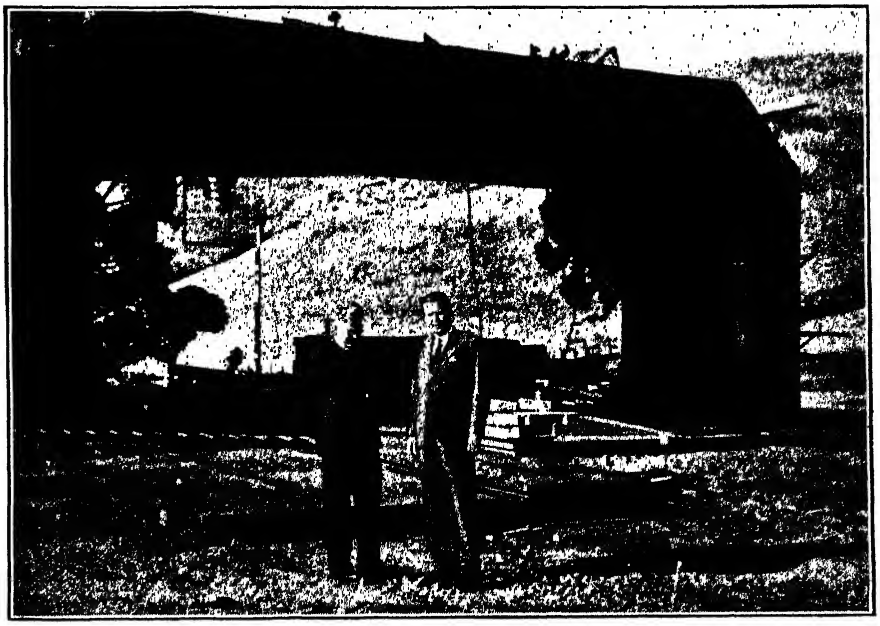
THE 184-IN. CYCLOTRON AT BERKELEY, CALIFORNIA

By Prof. M. L. Oliphant, F.R.S.

During a recent trip to the United States in an official capacity, I was fortunate to be able to repeat for a few hours a visit I made first in 1938 to the Radiation Laboratory in Berkeley, California. The earlier visit was made with the object of obtaining information which would enable me to build in Birmingham a large cyclotron. The 60-in. monster in the Crocker Laboratory was almost complete, and Lawrence had already begun to think of trying to push the cyclotron technique to its limit. We discussed in detail the difficulties of such a scheme, but these proved small obstacles in the path of Lawrence and his great band of co-workers. The theory of the cyclotron had recently been worked out, and it had been shown by the 'prophets' that existing apparatus which delivered 8–10 million volt deuterons was in fact the largest which could be made to work, owing to loss of resonance between the particles and the electric field due to relativistic change of mass. The Berkeley group under Lawrence promptly increased greatly the voltage applied to the electrodes of the new 60-in. cyclotron and showed that no such limit need in fact exist.

In the realms of nuclear physics the cyclotron is by far the most powerful tool which we possess, and in its present form in Berkeley it provides curies of activity of artificially radioactive elements and weighable quantities of transmuted elements. The possibilities for medical and chemical investigation are only now being realized, and the chemistry of carbon itself in complex organic and biochemical changes is being studied by use of the short-lived active carbon isotope now available in large quantities. Elements as heavy as bismuth can be transmuted by bombardment with the existing apparatus.

The giant cyclotron now under construction contains enough steel and copper to build two large destroyers, and is designed to push the cyclotron technique to the extreme limit. It will be capable of providing particles with energies approaching those of cosmic rays, and we can expect with confidence that these will open up fresh fields in atomic physics. The Rockefeller Foundation and the United States are to be congratulated on the vision displayed in enabling the inventor of the most remarkable apparatus used in scientific investigations the opportunity himself to direct the building of this great machine. Lawrence is assisted by a brilliant team of workers who have been associated with his work in the past. With Lawrence himself, many of these men are now doing work of more immediate national importance, but the project itself is proceeding under the guidance of Dr. Donald Cooksey, Lawrence's enthusiastic lieutenant.



MAGNET OF THE 184-IN. CYCLOTRON UNDER CONSTRUCTION AT BERKELEY, CALIFORNIA. In the foreground are Prof. E. O. Lawrence (right) and Prof. M. L. Oliphant (left). Photograph by Dr. Donald Cooksey, assistant director of the Radiation Laboratory.

It is certain that, when completed, the giant cyclotron will attract physicists from the whole world, and Lawrence expresses himself as the director of a piece of apparatus which will in happier times be shared by all who have the wish and the ability to do so. In front are the blue waters of San Francisco Bay; and behind, the warm hills scented by groves of eucalyptus trees. A physical centre of such importance in so beautiful

a part of the earth will draw scientific workers from every country. In Berkeley with Lawrence there is much of the spirit of the Cavendish, and in Lawrence there is one who, like Rutherford, can gather round him a team of men and inspire them to do great things.

Dr. Donald Cooksey, who has forwarded the photograph reproduced herewith, showing Prof. Ernest O. Lawrence (right) and Prof. M. L. Oliphant (left), has sent the following particulars of the cyclotron and the laboratory which is being built to house it.

The magnet is 56 ft. long, 30 ft. high and 184 in. wide. It rests on 1,200 tons of concrete, contains 3,700 short tons of steel and 300 tons of copper. The pole diameter will be 184 in., and the gap between the poles 40 in. The steel construction is complete except for the upper core and the pole tips.

The laboratory enclosing this magnet, which is about to be erected, will be a 24-sided building, on a spur overlooking the Berkeley campus and the whole of San Francisco Bay; in fact, it is directly opposite the Golden Gate, the elevation above sea-level being 881 ft. The views involved probably make it the most spectacular site for any physics laboratory in the world. The construction work has now been under way for about a year, and it is estimated that approximately two more years will be required for its completion. This cyclotron is being designed to give 100 million electron-volt deuterons.

OBITUARIES

Mr. H. M. Wallis

Henry Marriage Wallis died on November 10 at the age of eighty-seven in Reading, where he had resided since 1872. He was a member of a well-known Quaker family from Ipswich. He had travelled widely in Europe and North Africa, spending each winter in and around the Mediterranean. He was 'father' of the Reading Museum and Art Gallery, with which institute he had been associated for half a century as the honorary curator of vertebrates.

As the result of a deep passion for, and love of, Nature, Wallis became known for his multitude of observations, especially on birds and mammals. His knowledge (based on first-hand experience) was profound and was passed on to his fellows by contributions to a number of scientific and other journals and to the Press and by lectures—the latter covering many branches of science and history.

Wallis corresponded with Darwin on the subject of the hair upon the ears of new-born babies. Wallis also did research work on ancient breeds of pigs, having been stimulated by those he saw in Bulgaria and those depicted on Greek coins.

He was responsible for the acquisition of specimens of the British deer—red, fallow and roe (male, female and young of each)—from the herd of the late King George V at Windsor, which now make the magnificent groups in Reading Museum. The birds of prey of the Pyrenees were a special study of his, and I am indebted to him for minute guidance to the avi-fauna of that region. Besides his study of local birds and mammals, Wallis took a leading part in the experiment in 1930 of introducing a colony of large copper butterflies in the Kennet valley.

He was a founder member of the Reading and District Natural History Society and was president during 1891–93. He was also a member of the British Ornithological Union, the British Trust for Ornithology.

H. M. Wallis was a lovable and humble man and will be sadly missed by a multitude of friends, both personal and scientific. W. A. Smallcombe.

Mr. Richard T. Baker

We regret to record the recent death in Australia of Mr. Richard T. Baker. For thirty years Baker was curator of the Technological Museum, Sydney, and for thirteen years lecturer in forestry at the University of Sydney. He is perhaps best known to botanists for his comprehensive work on the Conifers of Australia, published in 1910, in which he was assisted by Mr. H. G. Smith, assistant curator and economic chemist at the Technological Museum, Sydney. Mr. Smith also collaborated with him in his valuable researches on the genus Eucalyptus, especially with reference to their essential oil, and the results were published in 1902. The conifers were profusely illustrated by numerous photographs of the trees *in situ* and of herbarium specimens, as well as photomicrographs showing anatomical structure, some of them in the colours with which they had been stained.

Baker also published a large number of small papers on various Australian economic plants, and these are scattered through the volumes of the *Journal and Proceedings of the Linnean Society of New South Wales*. Nearly all of them are accompanied by first-rate black-and-white drawings by the author, with full details of the structure of the flowers and fruit.

Baker was a fellow of the Linnean Society of New South Wales and served on the Council during 1897–1922. In 1922 he was awarded the Clarke Medal of the Royal Society of New South Wales, of which he was elected a fellow in 1894.

NEWS AND VIEWS

The World at War

IT is one of the conditions of the existence of a group of individuals as a society that certain rules for the guidance of the individual be obeyed. This applies as much to nations in their association with other nations as to individuals. A fundamental rule in international relations is that no nation should carry out an act of war against another without giving notice of its intentions. In spite of all the facilities of modern means of communication, Japan has thought fit to ignore this elementary procedure in its attack on the United States, thereby aligning its foreign policy even more emphatically with those of Germany and Italy in its total disregard of international law. It is yet another demonstration of the Nazi 'new order' of the supremacy of armed force, and of the worthlessness of any pretensions on the part of the totalitarian nations of conceding any rights or liberties to other nations. Japan is a relatively young nation which chose deliberately to model its future on that of the Western world. She has chosen bad mentors, and it must be a source of grief and despair to those Japanese men of science of international reputation like Honda and Yukawa, as it would have been to those of the older generation such as Kitasato, Noguchi, Omori, and Jogi Sakurai, that the nation should have allowed itself to be carried away by the machinations of the military party.

With the extension of war to the Pacific, Japan's so-called "China incident" becomes now a part of a vast conflagration which has girdled the earth. The greater part of Europe, Africa, Canada and the United States, most of the States of South America, the myriad isles of the Pacific in the hands of the United States, Great Britain, Australia and New Zealand, the eastern sea-board of Asia from Siberia to Singapore, the Dutch East Indies, Australia and New Zealand—all are directly involved; and it is safe to add that no nation or people at present at peace is unaffected. When the totalitarian powers have been finally broken, the Allies, who are pledged to democracy and freedom, must go forward with a world programme for reconstruction, the fundamentals of which will be based on the Atlantic Charter. President Roosevelt put the position bluntly in his radio address on December 9: he said that Americans "must begin by abandoning once and for all the illusion that we can ever again isolate ourselves from the rest of humanity . . . there is no such thing as security for any nation, or any individual, in a world ruled by the principles of gangsterism. . . . We are now in the midst of a war not for conquest, not for vengeance, but for a world in which this nation and all this nation represents will be safe for our children. . . . We are going to win the war, and we are going to win the peace that follows."

Dr. V. K. Zworykin: Rumford Medallist

THE American Academy of Arts and Science has awarded the Rumford Gold and Silver Medals to Dr. V. K. Zworykin for his invention of the iconoscope and other television devices. Dr. Zworykin was born in Russia, and educated in Petrograd, Paris and Pittsburg. Since 1929 he has been connected with the Radio Corporation of America and has been associate director of the research laboratories of that Corporation since 1934. Zworykin's name is world-renowned for his far-reaching researches in electronics and photo-electric cells, culminating in his invention and development, with a group of associate workers, of the iconoscope or 'electric eye', which forms the basis of the television system adopted in Great Britain and still in active development in the United States.

The iconoscope is a special form of cathode ray tube in which the fluorescent screen is formed of a mosaic of tiny photo-electric cells, on which is focused the television picture to be transmitted. The electron beam of the tube is caused to scan this screen, and the resulting fluctuations of potential, depending upon the relative illumination of different parts of the screen, are used as the source of the picture modulation signals for the television radio transmitter. Zworykin's work has also led to the electron-multiplier, for amplifying the signals produced by a photo-electric cell, and to other devices used in television transmission and reception. All this work is described in a number of papers by him and his co-workers published principally in the *Proceedings of the Institute of Radio Engineers*, New York, and in the *Journal of the Institution of Electrical Engineers*, London.

Training of the Disabled

AN interim scheme for the training and re-settlement of disabled persons, which is for the benefit of women and girls as well as of men and boys, is described in a leaflet issued by the Ministry of Labour and National Service. In addition to members of the Fighting Services, the Merchant Navy and the Civil Defence Services disabled on war service, the scheme is intended to cover civilians injured through air raids, factory accidents or in other ways, and is open to all persons above the age of sixteen. Some degree of preference may be given to those whose disablement is due to war service or to enemy action, but foreigners who have been disabled since the beginning of the War are also eligible. Training will be given in occupations connected with munitions work such as draughtsmanship, fitting, instrument making, machine operating, welding, inspecting and viewing, and for this purpose the courses of training will be similar to those in the existing schemes of the Ministry, but modified to suit disabled persons or particular types of disablement. It also will be given in other

occupations specially authorized for the scheme. The training will be provided at certain Government training centres administered by the Ministry of Labour, at special centres with experience in training disabled persons for industry, at technical colleges and similar institutions and at works. A maximum period of twenty-six weeks training will probably be sufficient. Throughout the training, in addition to proper medical supervision, weekly allowances varying from 42*s*. to 17*s*. for men and boys and 33*s*. to 15*s*. for women and girls will be paid, and each trainee will also receive a dinner meal or 5*s*. per week in lieu, daily travelling expenses, when necessary, and dependants' allowances. These allowances will be independent of any pension or other payment the trainee may receive in respect of his or her disability.

Evaluation of Individual Adjustment

"AN Evaluation of Adjustment based upon the Concept of Security" by Mary D. Salter has been published in the University of Toronto Studies (Child Development Series No. 18. Toronto: University of Toronto Press; London: Oxford University Press, 1940. 3*s*. net) as the first part of a larger study designed to provide an evaluation of important aspects of an individual's adjustment by means of a series of scales based upon the common concept of security. The technique used in this investigation utilizes the principle of internal consistency to construct an extra-familial and a familial scale of security designed to throw light on relations outside and inside the family, respectively. The results indicate that social insecurity appears most frequently with those who are dependently secure in the family and with those who are insecure and independent in the family. Tolerance is much more frequent with independence than it is with dependence, both for the socially insecure and the socially secure groups. Those who are socially secure and dependent tend to intolerance and familial insecurity.

Familial security in the early stages is of a dependent type and forms a basis from which the individual can work out gradually, forming new skills and interests in other fields. In its absence the individual is handicapped by the lack of a secure base from which to work, and at the college age such insecurity is at least partly due to friction on the issue of emancipation. Independence of the family is true independent security if the individual has formed requisite skills and dependencies outside the family without being involved in conflict with the family. Continued dependence on the family may make for inadequate adjustment if it seriously interferes with the development of skills in other fields. Extra-familial security is based partly upon social skills and partly upon dependencies on friends, both apparently being necessary and interrelated. Insecurity is due to a lack of skills or of friends or of both. Intolerance is a common form of compensation which may contribute to social security during the acquisition of skills, and is most effective if the individual has dependent security also or at least a fairly satisfactory basis of skills already formed. Lacking both these, compensation either becomes ineffective resulting in insecurity, or must be exaggerated to avoid insecurity, leading to the unusual forms of behaviour which characterize serious maladjustment.

University Staffs in the British Empire

THE "Yearbook of the Universities of the Empire" is an invaluable reference book, the last issue of which is dated 1940. In view of the numerous changes, probably mostly due directly to the War, which have occurred during the past eighteen months or so in the staffs of universities, this issue quickly lost much of its value. When, however, the Universities Bureau had to consider the preparation of the issue for 1941, it was found that, on account of the destruction of the Bureau's premises, the delays in obtaining information from overseas and the shortage of paper, it was possible to prepare only a Supplement to the existing volume (Supplement to the Yearbook of the Universities of the Empire, 1940. Published for the Universities Bureau of the British Empire. Pp. xxxi+255. London: G. Bell and Sons, Ltd., 1941. 3*s*. 6*d*. net). In this book, which is of the same format as the well-known Yearbook, the officers are given for each university followed by a list of changes of staff. The list is carefully set out to facilitate easy reference, and there is an index of names at the end of the volume. The Yearbook for 1940, with the Supplement, provide as up-to-date a record of university staffs in the British Empire as is feasible in these times. The Bureau is to be congratulated on its enterprise.

Tar Oil Washes

THE introduction of tar oil washes in Great Britain about 1921 resulted in the greatest advance in the control of fruit pests that has been made during the present century. With extension in their use came the demand for their standardization, as differences in source and process of manufacture had led to uncertainty in their performance. After a study of the insecticidal properties of the various components of the washes and their behaviour under different conditions had been made both at the research stations and the research departments of insecticide manufacturers, a small joint committee of representatives of the Association of British Insecticide Manufacturers and the Ministry of Agriculture was set up to consider the available information, and, if possible, to prepare specifications. After still further investigation, specifications and methods of analysis for both the miscible oil (black fluid) type and the stock emulsion (mayonnaise) type were successfully drawn up, which have been accepted by the Association and the Ministry, with the concurrence of the Government Chemist. The full data are available in Bulletin 122 of the Ministry of Agriculture (H.M. Stationery Office, 6*d*.). Members of the Association and most of the manufacturers of tar oil washes have agreed that their products shall conform to these standards, and purchasers are strongly advised to take advantage of this by requiring that any washes they obtain shall comply with the specifications.

Public Health Education in Mexico

THE August issue of the *Boletin de la Oficina Sanitaria Panamericana* contains an instructive article by Dr. Angel de la Garza Brito, director of the School of Hygiene of Mexico, on the present and future of education in hygiene in his country. The old preparatory school in public health which was reorganized in April 1938 gave instruction to 130 medical men, 184 nurses and 70 health officers, as well as to an auxiliary staff consisting of statisticians, laboratory assistants and social workers for venereal diseases. In 1941 the first regular course for medical officers of health was opened. Difficulties which have been encountered are due to an almost complete lack of modern text-books and special literature on preventive medicine and public health, the scarcity of full-time teachers and the absence of basic training in preventive medicine and hygiene. These defects have been partly remedied by the preparation of synopses on each subject, and by encouraging the study of foreign languages, especially English. It has also been suggested that hospital instruction should be supplemented by a sociological approach.

Urea Formaldehyde Glue for Plywood

PLYWOOD is made to one of two specifications, either D.T.D.427 or B.S.S.5.V.3, requiring resistance to three hours immersion in water at 60° C. (140° F.) and 100° C. (212° F.) respectively. At present urea formaldehyde resins are used for D.T.D.427 plywood, and Tego film (paper impregnated with a phenol formaldehyde resin and used in a dry state) for the 5.V.3 plywood. Although modified urea formaldehyde glues meet the requirements of B.S.S.5.V.3, they cannot be used in the manufacture of very thin plywood because of the swelling caused in the thin veneers by the wet glue, and because of the penetration that takes place after pressing. The phenol formaldehyde film type of glue is, of course, immune from these troubles.

To meet this difficulty, and to reduce costs, Messrs. Aero Research, Ltd., of Duxford, Cambridge, have introduced a foamed modified urea formaldehyde glue. The amount of glue applied by any ordinary means (glue spreaders or brushes) is in excess of the optimum amount ; by using the glue in the form of a foam an extremely thin uniform spread is obtained in terms of pounds of glue per square foot, although the glue layer has an appreciable thickness. Actually the volume of the glue is about doubled by a special beater machine before it is poured into the glue spreader. Under ordinary factory conditions it is possible to get a spread of 1·35 lb. of glue per 100 square feet. This foamed-up glue, known as Aerolite F.67, gives plywood meeting the requirements of specification 5.V.3. Because of the nature of the foam, it can be used with thin veneers. The press temperature required is 90° C., so that steam-heated presses are unnecessary and the older type of press common in Great Britain, with hot-water heating, can be used ; the use of pressing temperatures below 100° C. obviates any risk of over-heating of the wood with its attendant troubles. Messrs. J. M. Steel and Co., Ltd., of Kern House, 36–38, Kingsway, London, E.C.2, are the distributors of Aerolite glue, and all inquiries should be addressed to them.

Forests of British Honduras

THE annual report of the Forest Department of British Honduras for the year ending December 31, 1940, is an illustration of the failure on the part of responsible administrators to understand the principles of a true forestry management. Mahogany has been exported from the country for a couple of centuries and more. The report commences with the statement that "British Honduras is essentially a producer of raw materials for export, of which in the last eighteen years an average of 79·6 per cent has been derived from the forests. In 1940 there was continued improvement in the export trade, and particularly so for forest produce, in spite of war conditions." There was but slight disruption of communications with North America to which a considerable proportion of these productions goes and the United Kingdom Timber Control Department purchased the whole of the lumber output. The Conservator writes: "the work of the Department in 1940 was concentrated on the most important aims of the forest policy." This policy is apparently to develop the forest estate by the maintenance of the chief export, mahogany, and chicle, etc. This is not forestry. A timber merchant can do this ; nor can it be termed a 'forest policy'. The exploitation of the forests is apparently done entirely by licensees who set up their own mills.

That the forests so worked and the amounts of valuable timber they contain is to a great extent unknown is obvious from the statement in the report that "shortage of staff has, for years, made it impossible to do much exploration in advance of exploitation" ; there appears to be an idea that by giving longer terms to the licences issued, licensees will plan their work economically. In the history of forest lumbering this hope has ever remained a dead letter. The superior staff of this Department consists of a conservator and two assistant conservators. Both these latter were absent for a greater part of the year; and yet we are told that 79·6 per cent of the raw material exported from the Colony comes from its forests. It would have been interesting had the report told us the direction in which the sums obtained from this produce went. Do they go into the exchequer of the Colony and are they spent in the improvement of the conditions of the people ? If the answer is in the affirmative, how long will the forests stand the drain upon them in the absence of the introduction of a true conservative management which could solely be enacted and maintained by an adequate forest staff ? According to the report, the latter can only be considered to be present in name.

British Association Seismological Committee

THE report of the British Association Seismological Committee for 1941 has just been received. It shows that some progress is being made in spite of

war conditions. The new-type electrically driven recording drums for the Milne-Shaw seismographs are proving satisfactory in India. The rotation of the drum is particularly uniform and there is no 'backlash'. This result has been achieved by pivoting the electric motor eccentrically on a spindle, and permitting it to fall by gravity into mesh with the gear attached to the drum. It may be described as a 'floating' contact in place of the usual fixed centres. Difficulties in connexion with the International Seismological Summary are being successfully overcome at Oxford. Jeffreys has investigated the deep earthquake of June 29, 1934, and has obtained from it helpful readings of the receding (*DE*) branch of *PKP*. The table of *PKP* has thus been improved and a table also constructed for *sP*. Stoneley makes some very helpful and pertinent remarks concerning the integration of seismograms in connexion with the long-wave phase of earthquakes. There need now be no hesitation in accepting the usual identification of the early part of the long-wave phase (apparent velocities 4·4–4·0 km./sec.) as Love waves.

Compounding in Locomotive Design

MR. W. A. STANIER delivered the presidential address to the Institution of Mechanical Engineers on October 24, when he discussed "The Position of the Locomotive in Mechanical Engineering". Although a standard feature of marine reciprocating design, compounding has not found extensive favour in Europe except in France. In England it has been the subject of repeated trials—no less than 12 per cent of the papers ever read before the Institution are on compounding—and in theory it has obvious advantages over simple expansion. These advantages are specially marked at working pressures higher than 300 lb. per sq. in. Attempts in Great Britain have contained defects, condensation causing serious loss, and lack of understanding of the principles of steam flow have often rendered the engines more sluggish than their simple expansion contemporaries. Superheating, which brought fresh life to the compound engine on the Continent, has only been applied to any scale to one British type, the 'Midland' compound; within the limits of its size, good work has been done and is still being done by this class. It has, however, never been modernized as regards its cylinder and valve-gear design, so its actual efficiency is below that of the present-day simple expansion engine. It is also possible to understand now why the French De Glehn compounds, imported by the Great Western Railway in 1903 and 1905, did not give results superior to the simple-expansion designs of Churchward. It is impracticable to combine within the British loading gauge, however, both the large low-pressure cylinders required, and the bearing and crank dimensions required by compound locomotives.

Northern Ecological Association

THE Northern Ecological Association was founded by the late Mr. R. J. Flintoft, of Goathland, Yorks, who organized workers in various fields of natural science in their own localities in the north of England. Valuable work had been done in this way, and it was felt that the organization should not be allowed to lapse, but should be placed on a permanent basis. Accordingly a special meeting of the Association was held at York on November 23, and it was decided to re-enact the existing constitution and to adopt the existing name. The officers of the Association are as follows: *president*, Dr. W. Collinge; *secretary and treasurer*, Mr. J. L. Forrest, Eversfield, Goathland, Yorks; *editor*, M. Dallman.

Dr. E. N. Miles Thomas

DR. E. M. DELF, Department of Botany, Westfield College, London (at St. Peter's Hall, Oxford) writes: "Dr. E. N. Miles Thomas, who is widely known amongst botanists for her contributions to the study of seedling anatomy, retired from her position as head of the Department of Biology at University College, Leicester, in 1937. Thereafter she occupied a research room at Westfield College (University of London), and for a time continued her many professional activities. Her health, however, was already seriously impaired. The evacuation of the College to Oxford and other difficulties in connexion with the War situation probably added greatly to the overstrain from which she was suffering. Early in 1940 she was found to have lost almost completely her power of memory, a condition which is now unfortunately regarded as permanent, although her general health has somewhat improved. Her research effects are housed at the Jodrell Laboratory, Kew."

Recent Earthquakes

IN addition to being recorded on all the seismograms at Kew Observatory, the earthquake of November 25 was recorded on the electrometer record of the rain electrograph. This earthquake, which affected Lisbon, gave very large amplitudes at Kew. The real ground amplitude caused by *P* (18h. 08m. 22s. U.T.) exceeded 300 μ, the amplitude caused by *S* (18h. 13m. 45s. U.T.) exceeded 800 μ and the maximum may have exceeded 2 mm. A tentative interpretation of the records shows a compression from the south-west (azimuth 233°) and an epicentral distance near 3,600 km. The epicentre may thus have been near 28° N., 29° W., in the Atlantic Ocean south of the Azores. On December 4 an earthquake of considerable severity was felt at Rangoon though no damage is reported. On December 6 earthquakes were reported from Santiago and from San José in Costa Rica. Considerable damage was reported though full details are not yet available.

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has found the epicentres of the earthquakes of October 3 and October 5. The earthquake of October 3 at 16h. 13·2m. U.T. had its epicentre near lat. 40·6°N., long. 124·6°W., which is in northern California in the neighbourhood of Cape Mendocino. On the basis of instrumental reports from seven seismograph stations, the epicentre of the earthquake of October 5 at 10h. 11·2m. has been calculated to be lat. 15° S., long. 173° W., which is in the Pacific Ocean between the Islands of Samoa and the Fiji Islands. All interpretations and calculations are tentative.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Linkage of Physico-Chemical Processes in Biological Systems

IT is a truism of general physiology that living organisms are *actively* co-ordinated systems, that is, systems in which there is co-ordination of action as well as of structure. It would be no exaggeration to say that the discovery of the *quantitative* correlation of processes is the major task of modern general physiology, a correlation which, in the present state of science, can be exactly expressed only in terms of the existing concepts of physics and chemistry. Failure to recognize the linkage of intracellular *chemical* processes with *physical* diffusion processes involving unequal distributions of ions between the living cell and its fluid environment has often given rise to misunderstanding. The following simple example will serve to illustrate the point.

In Fig. 1, (I) represents the interior of the cell,

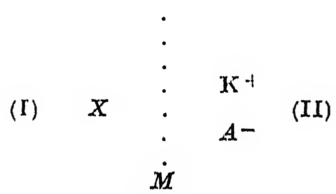


Fig. 1.

(II) the fluid environment, M the semipermeable cell-membrane. Within the cell is a dissolved *impermeable* neutral substance X, while in the extracellular fluid there is the ionized salt K^+A^-, where (for example) K^+ denotes the potassium ion and A^- a certain univalent negative ion, the membrane M being freely permeable to both. Fig. 1 represents an *initial* state.

We now make the supposition that the *practically irreversible* chemical reaction

$$X + A^- \longrightarrow Y^-, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

occurs within the cell, where Y^- denotes an *impermeable* 'complex' ion (using the word 'complex' in its widest sense). The chemical reaction (1) may involve the elimination of one or more water molecules and the active co-operation of an enzymatic system, but the simple formulation given in (1) suffices for the present purpose. The final state of the system is represented by Fig. 2, where we assume that there has been present in the system more than sufficient A^- to convert practically all the X originally present into Y^-.

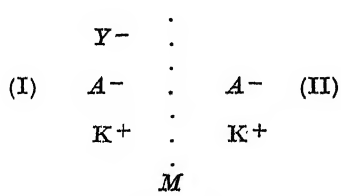


Fig. 2.

For simplicity (that is, for the sake of illustrating the ideas involved), we now assume (*a*) complete ionization of the salts KA and KY, and (*b*) applicability of the laws of very dilute ideal solutions. We have then the following relations (where C denotes molar concentration):

$$C_K = C_A + C_Y, \quad . \quad . \quad . \quad . \quad (2)$$
$$C_K C_A = C'_K C'_A, \quad . \quad . \quad . \quad . \quad (3)$$
$$C'_K = C'_A; \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

whence follows:

$$C_K = \tfrac{1}{2}\left(C_Y + \sqrt{C_Y^2 + 4\,C'^2_K}\right) \quad . \quad . \quad . \quad (5)$$

(the accented letters denote quantities referring to (II)).

Equation (5) shows that at equilibrium $C_K > C'_K$, and gives a quantitative expression for 'the accumulation of potassium ions in the cell against a concentration gradient'. In the present case such an accumulation is rendered possible by the occurrence of the reaction (1). This reaction involves *per se* a decrease of free energy, but this decrease of free energy is not directly and quantitatively correlated with any diffusion of potassium ions against a concentration gradient (and across an electrical potential difference). There is no mysterious 'energy-pump' at work, 'pumping' the potassium ions against a concentration gradient. The situation is simply such that the occurrence of the intracellular chemical reaction (1) produces a *down* concentration-gradient of A^- ions from (II) to (I), and the free-energy changes associated with the *down-gradient* diffusion of A^- offset (when necessary) those associated with the simultaneous, linked, and equivalent *up-gradient* diffusion of K^+. If the reaction (1) be sufficiently rapid, we may divide the process of passage of K^+ and A^- from (II) to (I), into two phases; the first is complete when the reaction (1) is (practically) complete and (I) contains only the salt K^+Y^-, while further diffusion of K^+ and A^- from (II) to (I) occurs in the second phase and completes the equilibrium.

Although not necessary for the preceding argument, it may be noted that at equilibrium we have also the osmotic pressure equation (ignoring for the present purpose all constituents in (I) and (II) except those already considered):

$$P_I - P_{II} = RT\,\{C_K + C_A + C_Y - (C'_K + C'_A)\}$$
$$= 2RT\,(C_K - C'_K) \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where P_I and P_{II} denote the hydrostatic pressures in (I) and (II) respectively.

Generally, we may suppose that, as the cell grows, fresh X is constantly being produced and as constantly converted into Y^-, there being always a sufficiency of KA in the fluid environment.

The foregoing simple example, though somewhat different, has been suggested by the recently published remarkable work of P. J. Boyle and E. J. Conway[1] on potassium accumulation in muscle and associated changes. It must be stated, however, that the highly simplified considerations of the present note

touch only the fringe of the ideas involved in the extensive investigation of the authors mentioned. Nevertheless, the present brief communication will serve a useful purpose if it directs attention to an important investigation which throws much valuable light on the difficult problem of the quantitative correlation of linked physico-chemical processes in a living system.

F. G. DONNAN.

Athenæum,
London.
Nov. 15.

[1] *J. Physiol.*, **100**, 1 (1941).

Role of Potassium in Yeast

IN our previous communication[1] it was described how ammonia could entirely replace potassium in yeast under suitable conditions. It became then a question of interest as to how the 'ammonia yeast' functioned compared with the normal or 'potassium yeast' when both were maintained under strictly similar conditions, except that the ammonium ion replaced potassium. The rate of fermentation of glucose, the reproduction in suitable media and the resting metabolism were examined.

Preparation of the yeast for examination. Two 5-gm. samples of the same baker's pressed yeast were taken, one immersed in Ringer-Barkan fluid (as described in ref. 1) containing $N/5$ NH_4Cl and no potassium, and the other in a similar solution, K being replaced by NH_4 ions. The mixture was bubbled with 3 per cent carbon dioxide and 97 per cent oxygen, the medium being changed every twenty-four hours. After four days there was no measurable amount of potassium left.

The 'potassium yeast' after centrifuging contained 205 m.eq. K/kilo moist yeast and no appreciable amount of ammonia, and the 'ammonia yeast' contained 248 m.eqs./NH_3–N and no potassium.

Fermentation. 1-gm. samples of the centrifuged yeasts were suspended in 10 c.c. of water and allowed to act on an equal volume of 6 per cent glucose. It was found that the mean rate of carbon dioxide production by the 'ammonia yeast' was 40 per cent of that for the 'potassium yeast'—this latter being 0·26 m.eq./hr./c.c. yeast suspension.

Growth and reproduction. Small platinum inoculations were made into 100 c.c. of sterile medium containing 2·5 gm. glucose, 0·5 gm. K (or NH_4) acid phosphate, 0·1 gm. $MgSO_4$, and 20 ml. of boiled 1/5 water extract of 'potassium (or ammonia) yeast'. A curious difference appears between the two yeasts. The 'potassium yeast' grows much faster at first, but reaches an upper limit after twenty-four hours. The 'ammonia yeast' is considerably slower at first, but after two to three days exceeds the 'potassium yeast' and passes on to a far higher level (about four times the number of cells). The early upper level of the 'potassium yeast' is not due to an exhaustion of the glucose by fermentation, as shown by the use of higher glucose concentrations leaving much unfermented sugar after twenty-four hours, but no appreciable change in the number of yeast cells. It appears to be related to an exhaustion of some substance in the yeast extract added.

Resting metabolism. The oxygen uptake at 30° C. was examined in the Warburg apparatus, 3 ml. being taken of a 1/100 suspension in a medium consisting of 0·095 gm. Na_2HPO_4, 0·080 gm. NaH_2PO_4 and 0·60 gm. NaCl made up to 100 ml. ($pH = 6·7$). The Q_{O_2} for 'potassium yeast' was found to be $-5·35$ and that for the 'ammonia yeast' was $-6·36$. Thus the resting metabolism of the 'ammonia yeast' is *higher* than that of the 'potassium yeast'.

Experiments such as described in the previous letter and in other communications[2,3] show that potassium exists in cells in the ionized form, and it would appear that the main biological reason for the accumulation of potassium in cells (at least those with distensile membranes) is a necessary process for the accumulation of appreciable non-diffusible material or such as the cell can retain[4]. At the same time, the potassium ion even in one-celled organisms, such as yeast, may exert some specific ionic effects, though the above experiments indicate only a difference between the ammonium and potassium ion without it being possible to say which, if any, plays a merely passive role. They show, none the less, that potassium (at least over 0·1–1·0 mgm./100 gm.) is not essential for fermentation, growth or resting metabolism of the living yeast cell.

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JOHN BREEN.

University College,
Dublin.
Oct. 3.

[1] [NATURE, **148**, 662 (1941).]
[2] Boyle, P. J., and Conway, E. J., *J. Physiol.*, **100**, 1 (1941).
[3] Conway, E. J., and Boyle, P. J., NATURE, **144**, 709 (1939).
[4] Conway, E. J., NATURE, **147**, 574 (1941).

Nature of the Disturbed Calcium Metabolism in Thyrotoxicosis and Myxœdema

VARIOUS theories have been put forward to explain the excessive calcium output in thyrotoxicosis including an increased metabolism *per se*[1], neutralization of acid products[2], direct stimulating catabolic action of thyroxin on bone, and a co-existing hyperparathyroidism[3]. For reasons to be given later, all these theories are unsatisfactory. As a result of direct experiments and observations[4] on normal subjects and cases of thyrotoxicosis, myxœdema and parathyroid tetany, a new theory has been formulated. It is believed that in thyrotoxicosis, an excessive secretion of thyroxin acts directly on the kidneys, stimulating them to increase their output of calcium. This may be achieved either as a result of the increased metabolism *per se* or by lowering the renal threshold for calcium.

As Aub *et al.*[1] have shown that an increased metabolism *per se* does not increase the calcium output, the excessive calcium loss would appear to be due to a lowering of the renal threshold for calcium. This leads to a fall in the serum calcium, and as a result there is an increased mobilization of calcium from the bones. In other words, the decalcification in thyrotoxicosis is due to a *vis à fronte*. In myxœdema there is the converse picture, where a diminished thyroxin secretion raises the renal threshold for calcium and causes the calcium output to fall.

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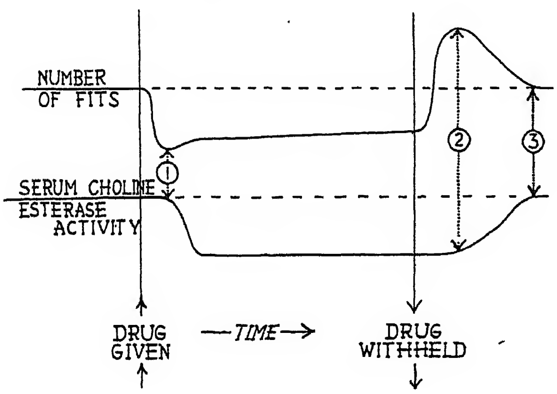
Nov. 19.

[1] Aub, J. C., Bauer, W., Heath, C., and Ropes, M., *J. Clin. Invest.*, **7**, 97 (1929).
[2] Hoennicke, E., *Biol. klin. Woch.*, **41**, 1154 (1904).
[3] Hansman, F. S., and Wilson, F. H., *Med. J. Austr.*, **1**, 37 (1934).
[4] Robertson, J. D., *Lancet*, **1**, 97, 129, 156, 216 (1941).

Mechanism of Drug Addiction and Drug Tolerance

It has been found that prolonged administration of 'luminal' (and other barbiturates) to human beings (for example, epileptics) and animals greatly reduces the cholinesterase activity of the serum, so that it reaches 10–2) per cent of what it was before the treatment with the drug. No change in cholinesterase activity was found, however, when the drug was added to serum *in vitro* (2·5 mgm./c.c.). It appears that the barbiturate does not act directly on the enzyme as in the case of eserine and other anticholinesterase substances. The pronounced decrease in cholinesterase activity which was found *in vivo* might be interpreted as a counter-adaptation, the activity of the cholinergic system being reduced by the narcotic, reducing thereby the demand for cholinesterase, which, consequently, slowly decreases.

It is known that when the drug is withheld from epileptic patients to whom it has been given for many months the number of epileptic fits rises sharply. They become much more frequent than they were during the drug treatment and before the treatment was started. After some time, however, the fits appear with very much the same frequency as before the treatment. In the accompanying figure both cholinesterase activity and frequency of fits have been plotted against time.



The peak in the number of fits when the drug is withheld may be compared with the great demand for drug when withheld in cases of drug addiction. The number of fits, however, is a conveniently more measurable quantity than the expressed desire for the drug in the latter case. It is suggested that the increased number of fits (at 2) is due to the fact that the narcotic effect of the drug, which diminishes the fits, wears off more rapidly than the counter-adaptation, namely the reduction of the cholinesterase activity. It should be noted that when the fits reach their maximum (at 2) the cholinesterase activity was still low. The fits, however, return to their 'normal' number at about the same time that the cholinesterase activity reaches its former level (at 3). Accordingly the optimal effect of the drug (greatest reduction of fits as at 1) is observed when the direct narcotic effect of the drug, as indicated by the number of fits, has already taken place, and the counter-adaptation (reduction of cholinesterase activity) has not yet adjusted itself. The best effect of the drug is thus observed when an apparent strong narcotic effect (few fits) is combined with a high cholinesterase activity (at 1). At 2 there is little or no narcotic effect (many fits) combined with a low cholinesterase activity.

These observations, apart from suggesting that the cholinesterase should have a therapeutic effect on the number of epileptic fits, might also explain the development of drug tolerance.

In the case of barbiturates one may therefore distinguish between a direct (D) and an indirect effect or counter-adaptation (C). In our case both could be estimated, D from the number of fits, C from the reduction of the cholinesterase activity. The velocity with which these two effects develop and wear off respectively is greatly different. If in other cases a drug should prove to produce two such similar effects, the condition for an increased demand for a drug after it is withheld (addiction), or that higher doses are gradually needed to obtain the same effect (tolerance), might generally be expressed thus: $\frac{dD}{dt} > \frac{dC}{dt}$, where t is time, and both $\frac{dD}{dt}$ and $\frac{dC}{dt}$ are positive in drug addiction, immediately after the drug is withheld, and negative in drug tolerance, immediately after drug is given.

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Nov. 19.

Drug Prophylaxis against Acute Anoxia

In the course of some oxygen-lack experiments, an opportunity occurred to test the prophylactic effect of ethylene-diamine theophyllin ('Cardophylin') against acute anoxia.

Mixture breathed	Time	Tension in mm. mercury of alveolar carbon dioxide	oxygen	Minute volume in litres.
Air	11.48	41·1	95·3	6·8
11·4 per cent oxygen	12.00	29·1	56·1	9·0
	12.05	0·4 gm. of 'Cardophylin' taken orally.		
Air	12.35	36·9	98·9	6·7
11·4 per cent oxygen	12.49	22·3	60·9	16·0

In the above table are given the results of one test. In this case 0·4 gm. of the drug was given orally. The pulmonary ventilation was much greater when breathing the low oxygen mixture after the administration of the drug.

The above effect was demonstrated in the minority of the small number of subjects investigated.

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Nov. 14.

Cobalt Manuring and Pining in Stock

It is well established from experiments carried out in New Zealand[1] and elsewhere that certain forms of pining in stock can be prevented or cured by the addition of cobalt to the soil. The cobalt content of the herbage is thereby increased to a value above that at which pining due to cobalt deficiency occurs. We[2] have demonstrated this in experiments in eastern Ross-shire.

Spectrographic examination of the herbage grown on soil which has undergone cobalt treatment has shown, in some instances, a marked increase in the molybdenum uptake, the content approaching that of teart herbages reported by Ferguson, Lewis and

Watson[3]. Data for two soils are appended. On soil A pining in sheep has definitely been both prevented and cured by the application of 2 lb. cobalt chloride per acre, and, although the molybdenum content of the herbage increases as a result of cobalt treatment, even 10 lb. per acre, a dressing considerably greater than any likely to be used in practice, does not increase the molybdenum content to a dangerous extent. Soil B, where a form of pining in cattle has been reported, but not definitely attributed to cobalt deficiency, carries a herbage which is initially quite high in molybdenum. Even 2 lb. cobalt chloride per acre causes a considerable increase in the molybdenum content of the herbage, and a content at which teart is liable to occur appears to be approached. It may be that the pining reported on this soil is a combined cobalt deficiency : molybdenum excess effect, and the addition of cobalt to the soil as a remedial treatment may have deleterious results. It appears from the work of Ferguson, Lewis and Watson that the uptake of molybdenum decreases with increasing soil acidity : the use of a cobalt-rich lime, as has been suggested in New Zealand, may therefore be dangerous.

In cases of cobalt-deficiency pining such as that occurring on soil A, the application of a cobalt-rich fertilizer is a simple and effective means of counteracting the disease, but it is evident from the foregoing that caution must be exercised in the general use of cobalt-rich fertilizers. More detailed investigation of the inter-relationships of cobalt, molybdenum and other trace constituents which appear to enter into the nutritional balance of the plant and the animal is necessary, and work on these lines is continuing.

COBALT AND MOLYBDENUM CONTENTS OF HERBAGE, FIFTEEN MONTHS AFTER COBALT TREATMENT, AS PARTS PER MILLION OF DRY MATTER.

$CoCl_2.6H_2O$ added lb./acre	Herbage from Soil A Co	Mo	Herbage from Soil B Co	Mo
0	0·08	1·7	0·07	6·3
2	0·22	2·2	0·20	9·2
10	0·63	2·4	0·89	10·0
80	3·20	7·5	2·75	14·2

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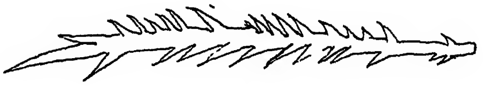
Animal Diseases Research Association,
Gilmerton, Midlothian.
Nov. 21.

[1] Askew, H. O., and Dixon, J. K., *N.Z. J. Sci. Tech.*, 19, 317 (1937).
[2] Stewart, J., Mitchell, R. L., and Stewart, A. B., *Emp. J. Expt. Agric.*, 9, 145 (1941).
[3] Jealott's Hill Res. Bull., No. 1 (March 1940).

A Factor in the Dispersal of Burdock (*Arctium Lappa*, Linn.)

THE hooks on the involucral bracts of burdock, by clinging to passing animals, secure the removal to a greater or less distance of the fruits from the parent plant ; but they do not secure the scattering from one another of the fruits contained in the burr itself. A chance incident that occurred some years ago, but which I have only recently investigated, enables me to suggest the means by which this desideratum is probably achieved. One of the boys in a class with which I was studying hooked fruits happened, after pulling to pieces a burdock burr, to lean his cheek on his hand : within a few minutes he complained of intense irritation in the skin of his cheek, and soon there appeared on his face a rash like that caused by the hairs of some caterpillars. Some of the copious yellow dust that falls readily out of the ripe burr of this species had adhered to his hands, so I attributed the discomfort to this substance ; but only now have I examined it microscopically.



The microscope shows that the dust is composed of very fine and stiff bristles varying in length from approximately 1 mm. to 2 mm. and in breadth from 0·04 mm. to 0·06 mm. ; their distal ends are sharply pointed, and their sides armed with numerous short spikes, as illustrated. These bristles form a dense tuft (pappus) on the summit of each fruit, and their attachment to the ovary is so brittle when ripe that the slightest jar causes them to snap off and so lie free in the mouth of the burr. Their many needle-like points are certainly likely to irritate animal skin acutely.

I suggest that these pappus bristles are instrumental in bringing about the break up of the burr and the scattering of its fruits apart from one another. When a burr has become attached to the coat of an animal many of the bristles are certainly shaken out, and some, probably many, will reach the animal's skin, irritating it and causing the creature to scratch at the burr and in so doing knock it in pieces and fling the fruits fairly wide apart from one another.

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Nov. 22.

Ascorbic Acid System in Barley

SZENT-GYÖRGYI suggested that ascorbic acid might play a part as hydrogen-transporter in some tissue respirations comparable with the role of cytochrome. This was supported by the discovery of an active ascorbic oxidase in a number of plant tissues. A difficulty which has hitherto retarded acceptance of Szent-Györgyi's suggestion has been the failure to discover any cellular reducing system, other than glutathione, capable of regenerating ascorbic acid from its oxidized form.

Though barley tissues do not yield any striking reaction for glutathione, they are well known to contain ascorbic acid and they also contain a reducing system which we found would readily reduce methylene blue. By manometric methods we were able to show the presence of an active ascorbic oxidase, freely soluble in diluted barley sap or phosphate buffer at pH 6. It was completely inhibited by $M/1,000$ cyanide and had other characteristics similar to the ascorbic oxidase previously extracted from other plants.

In searching for a hydrogen-donator which would maintain the activity of the system, we found that addition of $M/100 \rightarrow M/20$ lactic acid greatly increased oxygen consumption, although in barley sap without addition of ascorbic acid it had no effect. Titration with 2, 6 dichlorophenolindophenol showed that the presence of the lactic acid maintained the ascorbic acid in the reduced form. At the end of

the reaction, pyruvic acid was isolated as 2, 4 dinitrophenylhydrazone, confirming the removal of hydrogen from the lactic acid. Other hydroxyacids, namely, glycollic and tartaric, behaved similarly though less vigorously. Malic acid gave irregular results, and in this connexion it is noteworthy that we added no co-enzyme to the diluted saps. Hydroxyl groups were not oxidized in a number of other substances tried, including β-hydroxybutyric acid and catechol. Succinic and pyruvic acids were also found inactive. There is thus good reason to presume the existence in barley tissues of the system :

$$CH_3\,CHOH\,COOH + \text{Ascorbic Acid} \underset{H_2 \rightarrow}{\overset{\text{lactic dehydrogenase}}{}} \quad + \quad O_2 \underset{H_2 \rightarrow}{\overset{\text{ascorbic oxidase}}{}}$$

Lactic and pyruvic acids have been reported in barley tissues and we have no reason for believing this system unable to play a part in barley respiration. Mr. C. R. C. Heard, working in this laboratory, has found that addition of ascorbic acid accelerated the decomposition of hexosediphosphate by barley saps. A fuller discussion of the status of this system is being presented elsewhere ; but it may be remarked that it seems to us improbable that any one mechanism is solely responsible for the respiratory oxidations. It is, perhaps, significant that although catechol oxidase is absent from barley, we have been able to satisfy ourselves of the presence of small quantities of cytochrome.

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Nov. 24.

Elastic Scattering of Fast Electrons by Nitrogen Nuclei

SCHERRER and his collaborators[1] have recently published results indicating that the scattering of electrons of energies up to 3·5 Mv. by nitrogen nuclei is anomalous, in that the observed scattering is many times greater than that to be expected on Mott's theory[2]. In particular, they apply a correction amounting to nearly 400 per cent for the geometry of the expansion chamber. This correction is necessitated by the rigid criteria adopted for the selection of tracks for measurement, and they suggest that the agreement between my results and theory, in the region 0·4–1·1 Mv., might be due to the omission of such considerations. In my measurements, however, examination of the tracks was made, not by stereoscopic reprojection, but by microscopic examination of the images on the camera plates in the manner so successfully introduced by Blackett for α-ray collisions. Tracks which after collision are only a few millimetres long are then easily measured as regards general direction. Even with the stereoscopic method such as I used in later work, large-angle collisions are quite easily detected, although they cannot be measured very accurately.

As I have often stressed, the adoption of rigorous criteria in track selection is of great importance in securing reliable results, and with ample data available, Scherrer's angular limitation criterion is highly desirable. In common practice, however, the experimenter is usually faced with the unpleasant alternative of strict selection criteria plus large statistical fluctuation, or less rigid criteria accompanied by less statistical fluctuation.

In my work, a total of 201 collisions was considered in an energy range 0·4–1·1 Mv., whereas Scherrer observed only about eighty collisions in the same energy range. For scattering between 20° and 60° his results are, *in this energy range*, not in appreciable disagreement with theory when statistical fluctuations are considered. For angles greater than 60°, reference to my own results shows that the scattering rises somewhat above the theoretical values, although statistical fluctuations would not allow a comparison to within ± 50 per cent. From Scherrer's more limited data, however, he deduces an excess above the theoretical value by a factor of 10. In view of the fact that he finds an excess of about five times the theoretical value for energies so low as 0·15 Mv., whereas Neher[2], using a Faraday cylinder arrangement, found an excess of only 30 per cent at this energy for the light element aluminium, it seems possible that Scherrer's result may be a considerable over-estimation. Combined with Stepanowa's[3] results, however, the evidence is now strong that nitrogen exhibits marked excess scattering of electrons at energies greater than 1 Mv.

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Nov. 12.

[1] *Helv. Phys. Acta*, 85, 14 (1941).
[2] *Rep. Phys. Soc.*, 1938.

Origin of the Automatic Microtome

IN his very sympathetic obituary notice on W. H. Caldwell in NATURE of Nov. 8, p. 557, Dr. G. P. Bidder asks all biologists to remember that they owe to Caldwell the ribbon method of cutting paraffin sections. In this connexion I would like to direct attention to a short account of the invention of the microtome for cutting continuous ribbons of paraffin sections written by the late Sir Richard Threlfall, in *Biological Reviews*, 5, 357 (1930). Caldwell and Threlfall were contemporaries and friends at Caius ; both were then scholars and later on fellows of the College. In a characteristically personal manner, Threlfall recounts in his article how when he was still an undergraduate he discussed with Caldwell their joint invention, and he tells the part that he himself played in making the new type of microtome which was to become an essential tool of zoologists. Threlfall's article includes a photograph of a copy of the original instrument; this copy is now in the Science Museum, London. The original instrument is in the Zoology Department, Cambridge.

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Distribution of Energy among the Cathode Rays of a Glow Discharge

EXPERIMENTS have been carried out to determine the energy distribution among electrons originating in the cathode dark space of the glow discharge through gases. Two methods have been employed : a method of retarding potential applied to electrons which escape through a hole in the anode into a low-pressure region behind it; and a method employing electrostatic focusing and deflexion of the same issuing beam. The following general conclusions have been drawn from the experimental study :

(*a*) At low pressures and high voltages where the discharge is strongly abnormal, the issuing electrons

are substantially homogeneous in energy. This energy corresponds approximately to the potential difference across the discharge. This is the region where the discharge forms a useful source of electrons of homogeneous velocity for use in high-speed cathode-ray tubes and electron diffraction cameras.

(b) At higher pressures and lower voltages, the electron beam possesses a wide range of energies. The general form of this energy distribution is independent of current and voltage. The maximum of the distribution curve occurs always at the maximum energy, and this in turn corresponds closely with the potential across the cathode region of the discharge. In general, at constant pressure the greater the current the greater is the proportion of electrons which possess the full energy. As the pressure is increased, the relative number of electrons in the lower energy regions increases while the fraction of the current carried by electrons decreases. It would appear that in all cases the greater number of electrons originates at the surface of the cathode itself. Except at the highest pressures, there is no support for the conclusion of J. J. Thomson that ionization is uniform throughout the cathode dark space, an assumption which has been accepted generally as necessary to explain the observed potential distribution.

A detailed account of these experiments will be published elsewhere at a later date.

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Early Logarithmic Works

READERS of J. Henderson's bibliography of logarithmic tables ("Tracts for Computers", No. 13, Cambridge, 1926) will be aware of the interest attached to Ezechiel de Decker's "Tweede Deel vande Nieuwe Tel-konst" (Gouda, 1627), in which was first published the important de Decker-Vlacq table of 10-decimal logarithms of numbers from 1 to 100,000. After the existence of this work had been doubted by many authorities, a complete copy was found at Utrecht by van Haaften in 1920.

In September of this year my attention was directed by Mr. H. G. Ward, of the Harold Cohen Library of the University of Liverpool, to the existence of a copy of Vlacq's "Arithmetique Logaritmetique" (Gouda, 1628) among a collection of books bequeathed to the University by T. G. Rylands in 1900, and now housed in the Harold Cohen Library. On examining the volume, I found, bound in at the end, pages 1–36 (a–d^4, e^2) of the "Tweede Deel", forming a treatise on the use of logarithms in arithmetic. Title-page and foreword (both reproduced in facsimile in Henderson's tract) are wanting, so that neither the name de Decker nor the date of publication occurs. The logarithmic table, which is known to have been published in both de Decker 1627 and Vlacq 1628, is wanting as a part of de Decker's work, since the Liverpool copy of the table has the French (not the Dutch) sub-title, and belongs to Vlacq's work, as a part of which it is collated.

There is nothing obviously incomplete about the Liverpool copy of the introductory treatise; rather the reverse, in view of the final half-section e^2. It may well prove to be complete, when it becomes possible to obtain detailed information about the Utrecht copy. In the meantime, it seems desirable to put on record the existence of a copy in Liverpool.

Also bound in the same volume is a copy of the rare extra section of 12 pages of Briggs's "Arithmetica Logarithmica" (London, 1624), containing 14-decimal logarithms of numbers from 100,001 to 101,000, and 11-decimal square roots of numbers from 1 to 200, with first differences in each case. I mention this now because the section has also been described by De Morgan and by Glaisher (see Henderson's tract, p. 41), and in respect of the table of square roots their descriptions differ from one another and from the above.

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Nov. 18.

John Mayow, 1641–79

ACCORDING to numerous histories of science and similar works, John Mayow was born in London of Cornish descent. The writers of these works give the date of his birth variously as 1640, 1643, 1644 or 1645, with a preference for 1645. This preference is presumably due to a statement made by Anthony à Wood that Mayow was "descended from a gentile family of his name living at *Bree* in *Cornwall*, was born in the parish of S. *Dunstan in the West* in *Fleet-street, London*, admitted Scholar of *Wadham* Coll. 27. *Sept.* 1661 aged 16 years"[1].

In some recent researches, which are too long to describe here and which will shortly be detailed elsewhere, I have been able to show that Wood's statement is wrong. As it now appears that the present month of December is as near as can be ascertained to the tercentenary of Mayow's birth, we may here briefly summarize this new evidence that he was born in Cornwall in 1641.

C. S. Gilbert describes Mayow as "a descendant from the ancient and genteel family of his name, living at Bray, in the parish of Morval"[2]. The manor of Bray was acquired by the Mayows in 1564 when Phillip Mayow of East Looe bought it from Christopher Copplestone[3]. Wood's "Bree" is, therefore, the manor of Bray in the parish of Morval near Looe in Cornwall. A search in the parish registers of Morval, by the courtesy and with the assistance of the Rev. E. A. Saunders, vicar of Morval, showed that John Mayow, the second son and third child of Phillip Mayow and his wife, Frances Stukeley, was baptized in Morval Church on December 21, 1641. As confirmatory evidence we may quote here, with the kind permission of the Warden of Wadham College, Oxford, the following extract from the records of the College: "John Mayow (Mayouwe), matriculated 2 July 1658, received as commoner, but admitted scholar 23 Sept. 1659, said to be of Bree, Cornwall and aged 17". Thus the John Mayow of Wadham College is also the John Mayow of Bray in Cornwall, who, being aged seventeen in September of 1659 (he would have been eighteen in December), or possibly said to be of that age in July of 1658 (he would have been seventeen in December of that year), was baptized in Morval Church on December 21, 1641.

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[1] "Athenæ Oxonienses", 1st ed., 2, 474 (London, 2 vols., 1691–2); 2nd ed., 2, 637 (London, 2 vols., 1721). Italics occur in original.

[2] "Historical Survey of the County of Cornwall" etc., 1, 140 (Plymouth-Dock and London, 2 vols. in 3, 1817–20).

[3] *ibid.*, 2, 197.

GLASS FURNACE PROBLEMS

THERE has been little advance in glass furnace design since the invention of the Siemens regenerative furnace in the sixties. Such improvements as have taken place have been largely in the resistance of the various refractories to the temperature of which this type of furnace is capable, and even yet a producer-gas fired furnace can be run at a substantially higher temperature than the refractories themselves will withstand for long periods. The Society of Glass Technology, in co-operation with the Department of Glass Technology at the University of Sheffield, has given continuous thought to the problem of furnace design during the twenty-five years of its existence, and it was therefore appropriate that the twenty-fifth anniversary meeting which was held at Sheffield on November 19 should take the form of a symposium on glass furnace problems.

The morning session was devoted to two papers dealing with the fundamental aspects of heat transmission, of which one, by Prof. D. T. A. Townend and his associates in the Department of Fuel at the University of Leeds, referred to radiation from flames and furnace linings, and the other, by Mr. J. B. Wagstaff, of Messrs. Hadfields, Ltd., had particular reference to the use of heat-resisting steels in recuperators. The second session, in the afternoon, dealt with the problem (of more immediate importance to the manufacturer) of the possibility of determining figures which would represent the performance of glass tank-furnaces, and provided a summary of the work which has been carried out by the Furnace Sub-Committee of the Department of Glass Technology during the last few years.

In discussing the question of metal recuperators, it was pointed out that the conditions for heat exchange in gases are fundamentally different from those for liquids, in that there is a high temperature difference between ingoing and outgoing gases, and the large volume of gases to be considered travel necessarily at a low velocity. For temperatures below 600° C., cast iron is reasonably satisfactory, and from that to 900° C. alloy steels meet the case. Even the best alloy steels are unsatisfactory at temperatures in excess of about 900° C., and the high nickel steels have the additional disadvantage that they are readily attacked by sulphur compounds. A metal recuperator, owing to the possibility of welding, can be made leak-proof, but the ordinary refractory recuperator, while standing up to the temperature and corrosion conditions, usually leaks so badly as to diminish its efficiency to a serious extent.

Mr. Wagstaff dealt in considerable detail with the fundamentals of the design of metal recuperators, and a point of considerable practical importance is the way in which the efficiency diminishes with a deposit of slag or dirt on the recuperator tubes. This was stated to be due to the increase in thermal resistance through the tube itself rather than to any change in the transfer of heat from the flame through the recuperator due to variations in the emissivity of the surface. In the course of the discussion it became clear that while some metal recuperators have failed in the course of as short a time as forty-eight hours, others have been found satisfactory for periods up to ten years; the main point that was emphasized being the necessity for selecting the metal appropriately to the particular conditions of the problem.

Prof. Townend provided a masterly summary of the fundamentals of heat transfer by radiation, and sketched in outline the theories that have been advanced to explain the radiation from water and carbon dioxide in the near infra-red. There is growing evidence of the existence of what he described as "over-activated molecules of relatively long life", which are, however, capable of giving up extra energy almost instantaneously on collision with the appropriate molecule or surface. Some of the facts which have led towards this conclusion are that silica-coated thermocouples record much lower temperatures than plain metallic thermocouples in the same gas stream, showing the effect of the surface on the rate of transfer. It has been shown also that most of the radiation from the Bunsen burner comes from the outer surface or the hot cone, indicating that all the energy is not instantaneously released on combustion. It is known that the addition of a small quantity of hydrogen to a carbon monoxide flame decreases the radiation disproportionately, but that the time of combustion increases. This was offered as a partial explanation of the known 'cutting' heat of a water-gas flame versus the 'soaking' heat of producer gas. In the flame spectrum of carbon monoxide there are bands superimposed on the continuous spectrum which are believed to be due to the over-activated molecules referred to above.

The effect of luminosity in the gas flame on the transfer of heat by radiation was then discussed by Prof. Townend. It has been shown that the radiation is greater than in the case of non-luminous flames but falls short of that emitted by a black body at the same temperature. Important factors in the rate of transfer in furnaces are the calorific value of the fuel as this affects the flame temperature, good mixing of the air and gas, and, related to this, the turbulence of flow. The point that is sometimes overlooked by the practical man is that the flame must always be considerably hotter than the walls of the closure.

Prof. Townend's colleague, Dr. A. L. Roberts, discussed the question of the radiation from solids, and pointed out that most refractory materials are initially selective radiators, and showed diagrams indicating how the purity of the refractory material affects the flame and its emissivity curve. Contamination of the surface of refractories in use tends to make them less selective, whereas the most hopeful lines of research would appear to be to make the walls radiate selectively so that the energy would be mostly radiated in the region where it could be most easily absorbed by the substance to be melted. The texture of the surface also has an important bearing on the effective emissivity. Rough surfaces have higher effective values although they, again, tend to render the radiation less selective. There are, therefore, two contradictory facts, and only experience can show which of them has the most important bearing on flame transfer efficiency.

The afternoon papers were, as stated earlier, more largely of direct interest to the glass manufacturer. Mr. W. A. Moorshead summarized the principles involved in the calculation of furnace performances

with particular reference to the effect of changes in regenerator efficiency on the thermal balance sheet. Dr. W. M. Hampton put forward a proposal for a performance figure for glass tank furnaces. While the accurate determination of a thermal balance sheet provides all the information necessary, it involves so much time and work that some simplified method of calculation is anxiously required. It has been the custom in the glass industry to consider the simple ratio glass made/coal used, but it was pointed out that the amount of glass produced in a furnace bears no necessary relation to the amount of glass such a furnace is capable of melting, as commercial considerations frequently come into operation. It is clear that the fuel consumption of a furnace increases with the throughput of glass, and after considering many alternative bases for comparison, it has now been agreed by the Furnace Committee that the fuel consumptions of different furnaces should be compared on the 'no load' basis, that is, the amount of coal needed to maintain the furnace at a given temperature when it is not actually producing any glass. Since the fuel consumption also varies with the temperature at which the furnace is run, Dr. Hampton proposed—and curves were provided to enable the transformation to be carried out simply—that the fuel consumption should be calculated as at a standard temperature of 1400° C.

It has also now been agreed by the Furnace Committee that the input to the furnace should be reckoned in heat units instead of in terms of various fuels, and the proposed performance figure suggested as the area of the furnace per unit input of heat which can be maintained at a temperature of 1400° C. when no glass is being produced. Using the information collected by the Department of Glass Technology over the last four years on glass tank furnaces in various parts of Great Britain, it was shown that there is a definite correlation between the size of the furnace and its performance figure, and also that the most important factor in improving the performance is adequate insulation. Differences in design are apparently of minor importance.

The general impression left by the meeting and discussion was that the glass industry is fully alive to the necessity for fundamental research, and that by the use of some agreed basis it should be possible to compare the performance of tank furnaces employed in making very widely different types of glass. Such comparisons should enable the effect of variations in design or materials on the performance of furnaces to be estimated, and so lead to substantial improvements in fuel economy. W. M. Hampton.

CIVILIZATIONS IN TRANSITION

Although cultural penetrations usually follow predictable lines in accordance with proximity, degree of difference between the civilizations involved, and their relative prestige values, notable exceptions indicate the wide variability of human reactions.

In the symposium on "Civilizations in Transition", held on September 25 as part of the celebration of the fiftieth anniversary of the University of Chicago, Prof. Robert H. Lowie, professor of anthropology in the University of California, and Prof. Michael I. Rostovtzeff, professor of ancient history in Yale University, discussed phases of cultural infiltration.

Prof. Rostovtzeff, speaking on "The Destinies of Hellenism in the Near East", described the trends toward hegemony and toward subordination which existed simultaneously in the case of the Greek settlers in Egypt. At first the Greeks, bearers of a high culture, were an *élite*, organizing a complex bureaucracy which virtually undermined the royal power and which milked the native population of its wealth. Later, Prof. Rostovtzeff said, the tendencies towards cultural acclimatization began to take effect, and by the time of the rise of Roman power, the Greek creative force in Egypt had been exhausted.

After the death of Alexander the Great, a wave of Greek emigrants swept into Egypt.

Since the status of the Greeks was that of a privileged class, the higher strata of the native population naturally tried to acquire for themselves this status. The prerequisite for it was Greek education and participation in Greek life. Thus a certain part of the native population became gradually 'Hellenized' and some of them received from the king the status of Hellenes.

Prof. Lowie discussed numerous examples of primitive groups in which cultural transfer depended on such obvious factors as the conqueror-conquered relationship and geographical proximity, but also listed situations in which these factors were outweighed by customs and other cultural phenomena which prevented transfer of traits of civilization when other circumstances were apparently favourable. Speaking on "The Transition of Civilizations in Primitive Societies", he also pointed to societies in which culture spread from the conquered to the conqueror and across apparently insuperable geographical barriers.

Although contact between two cultures usually results in an exchange of cultural traits, it does not always have this result. Dr. Lowie cited as an example four tribes in the Nilgiri Hills of southern India all of which live within easy walking distance of one another. The Toda are buffalo-breeders; the Badaga raise millet; the Kota serve as smiths and musicians; the food-gathering Kurumba practise magic. Transference of traits among the tribes is inhibited by the intense caste sentiment that prevails. When a few Kota attempted to wear turbans, after the fashion of the Badaga, they were at once beaten up by their outraged neighbours. Geographically there is an ideal set-up for a levelling of cultural differences, but any such process is frustrated by the prevailing ideology.

Class consciousness hinders the free spread of ideas by checking one of its most natural promoters, intermarriage; and it is equally potent when material advantages are reserved to a dominant people.

In Ankole, an East African country, the subject Bairu cannot turn into independent stock-breeders so long as their Bahima overlords claim the right to own all productive cows. Another factor preventing exchange of traits is the emotional revulsion to a novelty which, however useful, flouts accepted

standards, as when Buddhistic scruples prevent the Buddhist from raising silkworms.

Although the raising of edible plants usually spreads rapidly from one culture to another, it is not difficult to find exceptions. Why did rice fail to penetrate Oceania? Why do the contemporary Tahitians, with the example of the Chinese colonist before them, disdain to raise it ? Why did potato cultivation remain confined to Andean cultures in pre-Columbian times even though wild species occurred to the north ? Why did the tomato, a native of South America, reach the Ijca of northern Colombia only in recent times ?

Though not all such instances are explainable, Dr. Lowie considers that a partial explanation is that borrowing of cultural traits is not likely to occur when the potential recipient possesses an adequate counterpart.

In discussing the influence of borrowed traits upon culture, Dr. Lowie pointed out that borrowed traits, because of their extreme novelty, seldom are acceptable to the religious aspects of a culture. He cited as examples the reluctance of American Indian tribes to accept horses and guns into their religious ritual and worship, long after both horses and firearms had been widely used by the tribe. The horse remained of little religious importance. Even though it was an object constantly prayed for, we rarely, if ever, hear of a supernatural horse on a par with the bear, eagle, beaver, or other animal spirits. One Crow band had a horse dance, but the celebrants believed that they derived their power from an eagle.

The principle that novelties are religiously inferior holds true for weapons as well. In 1805 the Crow, obliged to obtain firearms and ammunition from the village tribes of the upper Missouri, were still poor shots with the gun. The deficiency was soon overcome, and, what is more, the wresting of a gun in a hand-to-hand fight came to be recognized as an honorific exploit equivalent to the older bow-snatching. Yet in the preparations for the sacred sun dance it was explicitly ordained to shoot a bull without the use of a gun.

Dr. Lowie also referred to the Crow practice of beginning a war expedition on foot, out of respect for the ancient method of fighting, even though the warriors later mounted horses.

Prof. Rostovtzeff stated that while 'Hellenization' was effected among the well-to-do natives, it did not touch the masses of the population of the two monarchies, the peasants of the country and the artisans of the cities, towns, and villages.

In time, the Greeks became privileged servants of the king and soon a powerful bureaucracy grew up dominated by the Greek administrators. From the point of view of the masses, the Greeks were their oppressors. They extracted from them ever heavier taxes, they supervised their compulsory labour, they acted as agents of the Government in exercising an ever stricter control over their economic life. The native working classes complained to their protector, the king, but they soon found out that the kings were helpless to relieve their sufferings. The powerfully organized bureaucracy was stronger than the royal will. No wonder then from time to time the natives rose in revolt.

As the Greeks began to intermarry with Egyptians, Dr. Rostovtzeff declared, they became more and more influenced by Egyptian culture, and soon an 'Orientalized' type of Greek came into existence. The Greeks were gradually absorbed by their Oriental surroundings. Climate, food, environment had their natural effects. A new type was in formation. We know little of this type, but its existence is certain.

It is significant, for example, how rapidly the Greeks became 'Orientalized' in religion. From the very beginning they worshipped in Egypt the new 'Hellenized' god Sarapis, a blend of the Egyptian Osiris and certain Greek gods. They became more and more devoted to this god as time went on, and especially to his divine consort the mighty Isis, long familiar to the Greeks. There was also the growing devotion of the Egyptian Greeks to the various animal gods such as the great crocodile god, and to the pseudo-science of astrology.

Another symptom of 'Orientalization' was the gradual change in the spirit of the Greeks. The buoyant energy of the pioneers of the third century B.C., their creative force, gradually subsided. Creation was replaced by routine, the Greek tempo of work was followed by Oriental passivity.

By the time of the rise of Roman power, Dr. Rostovtzeff said, the Greek creative force in Egypt had been exhausted and Egypt and the entire Greek world became incorporated into the Roman Empire.

THE QATTARA DEPRESSION

By M. G. BEADNELL

THE account in NATURE of November 1 of the career of the late Dr. John Ball, technical adviser to the Geological Survey Department of Egypt, brings vividly before me his enthusiasm on the subject of the Qattara Depression Scheme, with which his name was so closely associated in Egypt.

Roughly speaking, the depression is shaped like an elongated mutton-cutlet, and has a total superficial area of 19,500 sq. km., two thirds of which are more than 50 metres below sea-level, and the remainder reaching a minimum of −134 m. at a point south-east of the tiny enclosed Oasis of Qara. Its greatest length, from west to east, is 298 km., and greatest breadth, from north to south, 145 km. The depression extends from nearly 80 km. from Siwa on the west to within 205 km. of Cairo on the east, and its most northerly boundary is only 56 km. from the Mediterranean.

Nearly a third of the floor consists of a damp mixture of sand, clays and salts, known as "Sabakha", an Arabic term applied to deposits having a fertilizing value. (This area is so enormous that a proposal was put forward at the time by a Cairo newspaper that the depression should be exploited for its economic value, as a parallel to that of the Dead Sea, but this was never undertaken.)

The existence of this low-lying tract was discovered only in 1917, and quite fortuitously. The

commander of a military patrol going through that part of Northern Libya was requested by the Survey of Egypt to take aneroid readings, and the result was so surprising that at the earliest opportunity a scientific surveying party was sent there to confirm the data obtained. This led to a visit to the region by Hussein Sirry Bey (now Prime Minister), at that time director-general of the Survey Department, accompanied by Dr. Ball, director of the Desert Surveys branch.

There and then was conceived the huge project of bringing the water of the Mediterranean to the depression through a 60-km. aqueduct, part canal and part tunnel, and utilizing its fall from the exit —about 250 m. below the summit of the escarpment— for the generation of electric power on an enormous scale. They calculated that evaporation would effectively prevent the resulting lake from rising to the level of the site of the power-station.

This scheme appealed immensely to the people of Egypt—always worshippers of everything on a grand scale—for they immediately saw a navigable canal connecting the sea with a vast lake over which they might sail almost to Siwa, as well as a natural and inexhaustible electrical supply of 250–350,000 kw., providing cheap power and light for the towns and villages of the Delta.

After some experimental outlay on ascertaining the nature of the strata to be excavated, the idea was entirely abandoned, as its cost would have been prohibitive and exhausted the exchequer before any returns could reasonably be expected.

A point of considerable interest is that in the Miocene and later beds of the 300-metre escarpment of Qattara, a discovery was made of fossil bones of prehistoric animals, descendants of the Eocene ***Arsinoitherium Zittelli*** and contemporary ancestors of the elephant, excavated nearly forty years ago in the Fayum Province of Egypt. Owing to stress of work, this find could not be investigated, and is known only to the finder.

Qattara is the starting-point of many of the sand-dune belts of the Libyan Desert. Wind-erosion is persistently disintegrating the clays, sandstones and limestones out-cropping on the face of the escarpment, the grains being unceasingly swept away and blown southwards to add to the ever-increasing volume of these dunes, the most deadly obstacles to the domination of the desert yet encountered by man.

FORTHCOMING EVENTS

MONDAY, DECEMBER 15

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Mr. J. W. Crowfoot: "Syria".

TUESDAY, DECEMBER 16

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. Maurice Ashby: "British Empire Drugs Production".

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. J. C. Drummond: "Recent Advances in the Science of Nutrition and their Significance in War-Time".

THURSDAY, DECEMBER 18

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir John Russell, F.R.S.: "Collective Farming in Russia and the Ukraine".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Dr. W. G. Radley and Mr. E. P. G. Wright: "Voice-Frequency Signalling and Dialling in Long-Distance Telephony".

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Éire: Roinn Talmhaidheachta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Report on the Sea and Inland Fisheries for the Year 1939. (P. No. 4657.) Pp. 30. (Dublin: Stationery Office.) 6*d*. [1111

Proceedings of the Royal Irish Academy. Vol. 47, Section B, No. 6: Salmon of the Owenduff (Ballycroy) River. By Arthur E. J. Went. Pp. 161–178. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [1311

Other Countries

Canada: Department of Mines and Resources, Mines and Geology Branch: Bureau of Geology and Topography, Geological Survey. Memoir 226: Palæozoic Geology of the Brantford Area, Ontario. By J. F. Caley. (No. 2458.) Pp. iv+176. 50 cents. Memoir 227: Jacquet River and Tetagouche River Map Areas, New Brunswick. By F. J. Alcock. (No. 2459.) Pp. iv+46. 25 cents. Memoir 230: Mineral Industry of the Northwest Territories. By C. S. Lord. (No. 2462.) Pp. vi+136. 50 cents. Paper 40–18: Report and Preliminary Map, Houston Map-Area, British Columbia. By A. H. Lang. Pp. iii+18+map. 10 cents. Paper 41–5: Preliminary Map, Manson Creek, British Columbia. By A. H. Lang. 10 cents. Paper 41–6: Vassan-Dubuisson Map Area, Abitibi County, Quebec (Summary Account). By G. W. H. Norman. Pp. iii+9+map. 10 cents. Paper 41–7: Northeast Part, Beauchastel Township, Temiscamingue County, Quebec (Summary Account). By E. D. Kindle. Pp. iii+5+map. 10 cents. Paper 41–8: Preliminary Map, Morley, Alberta. By G. S. Hume and H. H. Beach. 10 cents. Paper 41–9: Preliminary Map, Bighorn River, Alberta. By B. R. Mackay. 10 cents. Paper 41–11: Preliminary Map, Redcliff, Alberta. By J. S. Stewart. 10 cents. (Ottawa: King's Printer.) [1011

U.S. Department of the Interior: Geological Survey. Bulletin 908: Geology of Area between Green and Colorado Rivers, Grand and San Juan Counties, Utah. By Edwin F. McKnight. Pp. v+147+13 plates. 1.50 dollars. Bulletin 910–C: Fineness of Gold from Alaska Placers. By Philip S. Smith. (Mineral Resources of Alaska, 1937.) Pp. vi+147–272+plate 3. 30 cents. Bulletin 911: Ore Deposits in the Vicinity of the London Fault of Colorado. By Quentin D. Singewald and B. S. Butler. Pp. vi+74+21 plates. 1.50 dollars. Water-Supply Paper 848: Ground Water in Keith County, Nebraska. By Leland K. Wenzel and Herbert A. Waite; with Sections on Platte Valley Public Power and Irrigation District, Sutherland Project, by E. E. Halmos, and Central Nebraska Public Power and Irrigation District, Tri-County Project, by G. E. Johnson. Pp. iv+68+8 plates. 70 cents. Water-Supply Paper 869: Flood of August 1935 in the Muskingum River Basin, Ohio. By C. V. Youngquist and W. B. Langbein; with Sections on the Associated Meteorology and Hydrology, by Waldo E. Smith and A. K. Showalter. Pp. vi+118+8 plates. 40 cents. Water-Supply Paper 885: Surface Water Supply of Hawaii, July 1, 1938, to June 30, 1939. Pp. v+142. 20 cents. (Washington, D.C.: Government Printing Office.) [1311

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NATURE

SATURDAY
Dec. 20, 1941

MAN-POWER AND WAR PRODUCTION

THE dominant lesson of the War is that the quantity and scale of the equipment which the combatants can throw into the scales at the right place will go as far to determine the issue of the struggle as the military virtues of the rank and file or the skill of the commanders. The industrial effort of Great Britain and its Allies must be raised to a level from which the flow of equipment will swamp that of Germany. Not until it can be said of the Allied forces that, like the German fighting man, they are equipped with every offensive weapon and every device for their protection that forethought and ingenuity can provide, may our war production be regarded as adequate.

Ultimately war production resolves itself into the question of the disposition and control of man-power and woman-power, and in considering whether our industrial effort is adequate to our needs there are three main factors to be examined. The first concerns labour, the second management and the third staff work at the centre. The proposals outlined by the Prime Minister in the House of Commons on December 2, with the call for a further inroad upon the amenities of life, appear to lay the main stress upon labour, but the response in the subsequent debate to the Prime Minister's appeal for proposals for the development of the war effort indicates that Parliament is well aware of the importance of the second and third factors, as indeed the reports of the Select Committee on National Expenditure have already shown.

When Mr. Bevin called for a 40 per cent increase in production this winter, he justified by implication much of the criticism to which the Government has been exposed in this matter. That criticism has been essentially constructive, as is recognized in the whole procedure adopted by the Government in dealing with what Mr. Churchill termed the crisis of man-power and woman-power which will dominate the year 1942. The attention focused on the amount of man-power and woman-power by the White Paper which has now been issued, and discussions as to the means of directing our diminishing reserves to the points at which they can contribute most to the national effort, should not be allowed to deflect attention from the equally vital matter of the use to be made of the reserves thus deployed or of the forces already in action on the Home Front or in the Services. The full national effort will only be exerted when all possible reserves of man- and woman-power have not merely been brought into service but when their potentialities are being utilized to the best possible advantage.

It is on this question that there is the most serious reason for anxiety. A disquieting volume

of evidence, some of which was provided in the recent debate, some in reports of the Select Committee on National Expenditure, and some in the preliminary report of the Beveridge Committee on the use of skilled labour in the Services, indicates that management in the Forces and in industry has not been so efficient as it might be in eliminating waste. There is other evidence, notably in the handling of the concentration of industry, and of the distributive trades, the limitation of supplies and the registration of retail shops, of defective staff work at the centre leading to the dissipation or disappearance of labour which should have been released for war purposes by the closing of businesses or retail shops. The persistent reluctance of the Government to use boldly and imaginatively the wide powers, given to it by the Enabling Act, on the formation of Mr. Churchill's Government, is probably the most potent single factor in any uneasiness with which the Government's handling of this extremely complicated and difficult question of man-power and woman-power is still regarded.

If the Government has never taken full advantage of the psychological value of the Enabling Act, it is the more important that nothing should be done to impair whatever fresh opportunities the new National Service Act may afford. There should be no possibility of fresh charges of discrimination between class and class or of causing friction that may endanger single-minded devotion to winning the war. The exclusion of married women under thirty from conscription, whether or not they have home ties or duties, may easily engender a sense of unfair discrimination against the unmarried woman, particularly if already employed, or lead to untoward or undesirable social consequences unless the situation is carefully handled on some such lines as those now to be applied in the new system of reservation for men. Sufficient substance has already been forthcoming for criticisms of wasted man-power for the country to be entitled to an assurance that when the Government and industry receive these immense supplies of new labour they will be more efficiently used than those already available. The immense demands made on leadership and management by the system of individual rather than group reservation are scarcely realized. Sir John Wardlaw-Milne's comments regarding the Special and Central Registers voice an anxiety widely existent among scientific workers and one which will not be dispelled while there is any evidence of undue tenderness to management or workers who put selfish or sectional ends before the national interest.

The system of individual reservation will be welcomed by scientific workers, who have already from time to time expressed serious concern as to the use which is being made of Great Britain's scientific man-power. The closer scrutiny of the essential character of every man's work, however, makes demands on management as well as on the new man-power boards which will involve no small measure of public spirit and sound judgment, if their purpose is to be served and if no bottlenecks are to be created in any transfer of workers. There should be opportunities for much fuller co-operation by the professional associations of scientific men, and the new system is likely to call forth their utmost sense of public responsibility.

To remedy the lack of co-ordination and utilization of scientific and technical man-power, a conference of the Association of Scientific Workers in Birmingham has already suggested a programme for the full employment of technical staff, the pooling of technical information between the Government and industry and adequate training facilities for inexperienced personnel (see p. 759). Peace-time methods of organization were alleged to be preventing the fullest use being made of the reserves of existing laboratories, and it was also stated that production has been impeded by the absence of systematic pooling of scientific information. Certain of these criticisms and proposals will doubtless be further explored at the open Conference on Science and the War Effort convened by the Association in January, particularly at the session on January 11, when the material collected by the Association's Industrial Committee on the utilization of scientific personnel will be considered.

In the meantime, Mr. Bevin's decision to establish in the Ministry of Labour machinery a proper appointments department including the Central Register (see p. 747) will be carefully watched. "The time has come", he said, "when proper provision in the technical branches of industry, right up to managements, should be conducted by the State, and the right people within the department should be appointed to handle it as a specialist's job." That is an important step, and when implemented should do much to secure the more effective use of scientific and technical man-power and the appointment of managers capable of the staff work upon which so much depends if the new supply of labour is to be fully utilized. The present position of the employment of physicists is dealt with by the honorary secretary of the Institute of Physics on p. 756.

It has been widely appreciated that a more comprehensive survey of man-power cannot be made public without enlightening the enemy. Mr. Bevin's inability to place the Beveridge Report before the House is understandable. So, too, is the recognition that Britain lacks the man-power to maintain a great Navy, Army and Air Force and at the same time a sufficiently vast

industrial output. That main conclusion of Mr. J. D. Biggers's survey on President Roosevelt's behalf of British war production had already formed the basis here of an argument for a comprehensive strategy. What stands out above all else at the present time is the emphatic demand for careful and efficient administration. The need for perfecting the organization and use of man-power becomes greater, and the chief concern of most of the critics has been to strengthen the organization so that it may be equal to the burden placed upon it.

It cannot be fairly suggested that over the whole field output has fallen, as a result of slackness or indifference or absenteeism by the workers, much below what it would have been right to expect. The great body of workers, men and women, have worked well and consistently in conditions to which the War of 1914–18 could show no parallel, and Mr. Bevin's spirited defence of them is fully justified. Moreover, to some extent, what loss of output has been due to the workers, has frequently been the result of inefficient management as, for example, the absenteeism due to the attempt to work excessive hours, or sickness due to failure to provide adequate transport arrangements, canteens, efficient heating or ventilation and precautions against accidents. These are all day-to-day staff matters in industry, and the very fact that there have been such failures in Government factories, as well as in private industry, is bound to lead to some anxiety, in view of the increasing importance of such staff work with the growing influx of women in the war factories.

The utilization of married women, whether with or without children, and particularly on part-time work, involves even more complicated questions of administration and closer attention to welfare work. Apart from the questions of training, transport and hours, the provision of canteens and the like, there is the difficult question of shopping. Not all shopkeepers are as helpful as they might be to the industrial worker, and there is already a certain amount of discontent at the way in which a sheltered position is being used against the general interest. Government action in regard to shopping hours and facilities may become as imperative as in regard to the provision of crèches or day nurseries where local authorities or factories are slow to act. The chemical industry has already set an example in methods of co-operation which other industries might study with profit.

What is required, in fact, is not merely organizing ability and energy, but also sympathetic and imaginative insight into the needs and problems of potential and existing war-workers. It is this that gives special significance to a letter of Prof. Norman Bentwich in *The Times* regarding the use of neglected older men and women experienced in administration work, who are on the Central Register. Many such men and women would be content to do modest administrative work in the Services and would willingly be directed by their juniors in age. They might well supply that reservoir for the staffing of the welfare and administrative work of Government factories, which the Civil Service is untrained to provide and of which the Government, as the largest employer of labour, is in great need in the ordnance factories which have come or are coming into production. Prof. Bentwich suggests the formation of panels in the large towns and civil defence regions to interview those resident in the area and registered on the Central Register, with a view of recommending what use could be made of their services locally.

An admirable example of how the area boards themselves can contribute in such matters as the staggering of hours was described by Sir Edward Crowe in a lecture "Co-operation for Production" given before the Royal Society of Arts on November 28. The delegation of increased powers upon the regional boards of the production executive has been strongly urged as a means of revolutionizing output, coupled with effective staffing and the establishment of much closer relations with the industrial units. The work they have already done in removing bottlenecks, as described by Sir Edward Crowe, does indeed warrant the belief that there are wider spheres in which such boards could act promptly and with decision, and remove from the ministerial plane details of executive work which are properly handled by officials, as the Select Committee has already suggested.

The idea of a War Cabinet free from departmental responsibilities, the members of which could devote themselves to the major tasks of planning and of policy, like the establishment of a Ministry of Production to which Sir George Schuster inclines, is still resisted by the Prime Minister. None the less, Sir George's call for a new spirit as the greatest thing of all will meet with a wide response. It was apparent in the debate that on all sides of the House there are those who share his regret that the Government has not taken the step of enrolling every one for national service with payment on a subsistence basis during the War, and Sir George's suggestion of an expert committee to report on the effects of the present taxation system on industry has been warmly welcomed. In pressing for more unified direction of programmes at the top, for some organization for providing an independent check on the working of the Government machine with the view of learning from our errors, and for a thorough overhaul of departmental personnel and office methods, among other matters, Sir George was voicing beliefs widely held among scientific workers.

RELICS OF RICHARD JEFFERIES

The Nature Diaries and Note-Books of Richard Jefferies

With an Essay, "A Tangle of Autumn", now printed for the first time. Edited with an Introduction and Notes by Samuel J. Looker. Pp. 82. (Billericay: The Grey Walls Press, 1941.) 8s. 6*d*. net.

JEFFERIES has been dead for half a century, while three of his posthumous works were published in 1889, 1892, and 1909. Mr. Looker's scrap-book (it is scarcely more than that) of Jefferies' jottings will, therefore, come as a surprise to most people who, since Jefferies died at the age of thirty-eight after publishing twenty books in his lifetime, must have believed that only private letters remained to be read. Mr. Looker's remains, except for the short essay, "A Tangle of Autumn", are unhappily like the dead leaves brushed together by the gardener after the tree has shed them. They consist, apart from the essay, of a "Nature Diary" written between August and October, 1879, a notebook of stray gleanings between August, 1883, and July, 1884, and a couple of poems published in periodicals. The rest of the book is filled in by a longish introduction, a short bibliography, explanatory notes by the editor, and quotations from the published books where Jefferies had worked up an entry in the diary or notebook. It is not much of a harvest (the poems were certainly not worth reprinting), but the editor has at any rate performed a labour of love.

The mistake that nearly all commentators have made about Jefferies is indiscriminate praise, and Mr. Looker is no exception. It does his fame no good at all to speak of him as a great philosopher and profound metaphysician, which he emphatically was not. Many of the jottings in the notebook are obviously first drafts of "The Story of My Heart", a book which is now forgotten and, as the product of an almost pathological neurosis, not unjustly so. In that book Jefferies was stretching out towards "an existence infinitely higher than deity", which is rather like saying "I desire a life infinitely more deathless than immortality", and much of this fragile introspective stuff appears in the notebook in a briefer but not more intelligible form. The following is typical: "Aristotle: that God and design and all is a failure and immortality and soul: we must find something else: and reject the chart but sail the voyage and find a new thing, unforeseen". It is hard that poor Jefferies, who suffered so much from illness, disappointment, poverty and loneliness, should have his memory plastered with such babblings as these.

The essay is full of Jefferies' descriptive charm and eloquence (his strength was always in the objective, and it is sheer cruelty to his memory to resuscitate the subjective brooding of a frustrated life). But it is Jefferies at a good level average, not Jefferies at his best. The diary is very pleasant, and in its terse, brief, truncated observations not unlike Gilbert White's diaries, though not so good.

My own view is that Mr. Locker would have done better to have given us an anthology of Jefferies's published writings, with occasional passages from the unpublished work, each section of the florilegium illustrating some particular phase of the writer's genius. For example, Jefferies as a regional writer, as Clare, Bloomfield, Thomas Hardy, William Barnes and Gilbert White were. Jefferies was emphatically the poet-naturalist of a particular region, the Wiltshire-Berkshire borderland, though likewise of the South Downs and the once green belt of London. He was not a traveller like Hudson, and indeed he hated change:—"Let change be far from me; that irresistible change must come is bitter indeed. Give me the old road, the same flowers, the old succession of days and garland, ever weaving into it fresh wildflowers from far and near." He and Alfred Williams were the tutelary spirits of White Horse and Liddington Hills and it is good that a memorial stone has recently been raised here to their joint memory. In these days of standardization and diffused uniformity, to dwell on the regionalism of our choicest English writers would be a service not only to literature but also humanity.

Yet Jefferies' regionalism was incomplete, and there is a passage from "Field and Hedgerow" in Mr. Looker's pious collection which sharply illustrates in what sense it is so: "I wish the trees, the elms, would grow tall enough and thick enough to hide the steeples and towers which stand up so stiff and stark, and bare and cold, some of them blunted and squab, some of them sharp enough to impale, with no more shape than a walking stick, ferrule upwards, every one of them out of proportion and jarring to the eye. If by good fortune you can find a spot where you cannot see a steeple or a church-tower, where you can see only fields and woods, you will find it so much more beautiful, for Nature has made it of its kind perfect." What an extraordinary passage! Even Hudson, who was decidedly crotchety in his dislike of gardens and his indifference to the cultivated field, would never have committed himself to so outrageous a

myopia as this. It is not merely outrageous but silly, because the "fields and woods" are not pure Nature any more than the steeples and towers are man-made only. The latter are Nature working upon the works of man and the former man working upon the works of Nature with the result of a perfect synthesis between them, not to be matched anywhere else in the world. Yet Jefferies missed this unique beauty!

We shall do good rather than harm to the memory of a great Englishman if we recognize frankly that there is a fair amount of nonsense in Jefferies, that he was a more limited writer than either Hudson or Gilbert White and that his metaphysics will not bear looking into. They lack the stuff of thought. But as an observer of the familiarities of his own countryside no writer was greater than Jefferies, and to that power of seeing was often wedded an exquisite sensibility to the sheer beauty of the natural scene. His style can be monotonous, but at its finest it is that of a true poet. He could draw character too: Is there anything of its kind to touch his picture of a yeoman in "Amaryllis at the Fair"? "After London", too, is a very fine story, while his delight in colour and bird and beast and flower and fish and the great sun over all is true elementalism. So, if he lacked certain qualities as a writer, he possessed grace abounding in others.

H. J. MASSINGHAM.

PHYSICS OF THE SOIL

Soil Physics

By L. D. Baver. Pp. xi+370. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 24*s*. net.

SOIL physics, although a science having but few devotees, has grown up in two separate divisions, one dealing with soil as a habitat for plants and the other for large public buildings and roads, etc. Unfortunately these two divisions are still in almost water-tight compartments with respect to each other, there being neither any appreciable co-ordination between the two sets of workers nor, for so far as the agricultural workers are concerned, any ready access to the journals in which the civil engineering workers publish their results. The consequence is that text-books form the only easy means of finding out what the other workers are doing. The civil engineers are much better provided for than their agricultural confreres in this respect, as several good text-books have been published for them in recent years, while the last standard text-book on soil physics from the agricultural side was Keen's monograph published in 1931 and long since almost unobtainable. Now comes Baver's book to fill this important gap.

The author himself is well known for his researches in soil physics. But he has been a teacher as well as a research worker, and this book is the result of many courses of lectures he has given. Further, as he himself says in his preface, he has been fortunate in having ready access not only to the American but also to the extensive and very scattered European literature on soil physics. The result is a book containing references to the work of a great number of workers, and therein lies its chief limitation for the student but great utility for the research worker: for the incorporation of so much of the literature has been done at the expense of clarity in outline in some places where a clear outline could, in fact, have been given. Further, the author has not always quoted quite enough of some published work to make it self-explanatory, nor has he always indicated which points of technique in quoted work are fundamental to the interpretation of the results or to the use of the method and which are more or less arbitrary.

The book discusses all the subjects that usually come under the heading of soil physics from the agricultural point of view. It begins with a historical summary of the early work, and the reviewer himself was particularly interested in the many references made both here and in the body of the text to the work and results of the early pioneers. Then come two chapters on the mechanical composition of the soil, the definition, structure and properties of clay, and the various methods of mechanical analysis that have been devised and used. Mechanical analysis is discussed in great detail and on the whole very well, but it is marred by slurring over the concept of equivalent particle diameter. The author discusses all the main assumptions involved in obtaining Stokes's Law for the velocity of a freely falling sphere and discusses the complications occurring when one tries to apply it to soil particles, but the whole discussion is really trivial since he does not mention in this context that most clay particles are nowhere near spherical, and this introduces a far greater uncertainty into the interpretation of the results than all the other factors he has discussed. What he has not stressed is that the mean settling velocity of a non-spherical particle in water at a given

temperature has nothing whatever to do with Stokes's equation. The value of the equation is to transform this velocity into an equivalent particle diameter using a somewhat arbitrary value for the density of the soil particle.

The chapters on soil structure, soil air and soil temperature maintain a high standard, but that of soil water is less satisfactory. There is still a surprising confusion in the minds of most soil workers on the fundamental conceptions of soil water, which is reflected in this chapter by an unfortunate vagueness in some of the fundamental concepts and in particular in some of the consequences of these concepts. As an example, there is quite a good account of the concept of capillary potential or *pF* of the water in the soil, but the author does not seem to have realized explicitly the necessary connexion between the distribution of pore sizes in a sand or soil and its *pF* curve, with the consequence that a number of results on soil permeability are given as perhaps unexpected experimental results instead of obvious deductions from the underlying theory.

The last two chapters deal with the application of soil physics to soil cultivation and to erosion control. The former gives an excellent account of Nichol's work on the plough, and of the conditions one would expect in an ideal seed-bed, without, however, showing how far plants respond to these conditions. It also discusses briefly but adequately the effect of keeping the soil surface mulched. The last chapter discusses briefly such topics as the effect of slope and vegetable on soil and water run-off and on the rate of infiltration of water.

The text is well supplied with the relevant figures and tables needed to illustrate the main points discussed, and the book itself is, needless to say, very well produced. It forms a valuable addition to the very small library of books devoted to soil physics and it will amply repay most research workers and lecturers in soil science the time taken to study it. E. W. RUSSELL.

A PHYSICAL TREATMENT OF THE RAMAN EFFECT

Scattering of Light and the Raman Effect
By Prof. S. Bhagavantam. Pp. x+333+2 plates. (Waltair: Andhra University, 1940.) 15 rupees; 22*s*. net.

A BOOK on the Raman effect, written from a physical point of view, has been badly needed for some time. Since the discovery of the effect in 1928, there have been several attempts to review and collate the enormous literature which has grown up in the succeeding years. Although there are now several good bibliographies, and Hibben's excellent book on the chemical applications, Professor Bhagavantam is the first to give a general account of this phenomenon in English, with proper emphasis on the physical aspects. Almost half the book is quite properly devoted (as the title indicates) to the general subject of light scattering. In addition to providing a good up-to-date account of the basic phenomenon, this method of treatment helps to make clear the relation of the quantum theory to the classical theory of light scattering, and the extent to which classical ideas (for example, anisotropy and polarizibility) may usefully be employed in the interpretation of Raman spectra.

Any treatment of the Raman effect is naturally based on the theory of Raman spectra of diatomic and polyatomic molecules, and this is given with considerable skill, the essentially mathematical parts being relegated to appendixes. Applications of Raman spectra to problems of molecular structure, of crystal structure and to a variety of problems in physical, inorganic and organic chemistry are presented in five separate chapters. A particularly valuable chapter is included on experimental technique, since Professor Bhagavantam is an outstanding contributor here, and to obtain really satisfactory Raman spectra is not so easy as is generally supposed. In this connexion the description of the gradual discovery of the phenomenon is of considerable interest.

The only serious defect which the reviewer has noticed is the virtual omission of the interpretation of the magnitudes of Raman frequencies in terms of a molecular model with definite restoring forces between the atoms. The knowledge of inter- and intra-molecular forces which has been obtained from the Raman effect by this means is now very considerable. In this connexion the explanation of the breadth of the Raman bands of water given on p. 156 as "due to the existence of polarity and close packing" is not at all adequate. The exposition, while generally very clear, is occasionally marred by careless phrasing. For example, on p. 175 it is stated "that for a Raman line to occur with appreciable intensity either $\left(\frac{\partial \alpha}{\partial q}\right)_0$, or $\left(\frac{\partial \gamma}{\partial q}\right)_0$, or both should not vanish".

On the whole the book can be warmly recommended to anyone wanting an elementary treatment of this rapidly expanding branch of molecular physics.

G. B. B. M. SUTHERLAND.

GENETICS IN THE U.S.S.R.

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An opportunity to see old problems in new circumstances and discussed by new-comers is rare enough to be usually worth taking. Interest is added when the problem is the central one of biology and the speakers are Russians engaged in trying to build a society about which there may be as many opinions as observers, but which at any rate can be said to contain some novelties of a far-reaching character. Such an opportunity is provided by the report of a Conference on Genetics and Selection held in the U.S.S.R. in 1939. The proceedings[1] have been translated for the Society for Cultural Relations with the U.S.S.R. by Mrs. Beatrice King. The material thus made available was discussed at a meeting at the Caxton Hall on October 5, 1940. While the original Conference and the Caxton Hall meeting were noticed to some extent at the time, and rumours of genetic controversy occasionally reached Great Britain[2], it seems proper now to make some attempt to evaluate any contributions to genetic thought which may have been made in connexion with them.

First, the genesis of the Conference should be noticed. It was held under the auspices of a philosophical review, *Pod Znamenem Marxisma*, and its purpose was to determine whether any, and if any then what sort of, genetics should be taught in schools and the lower reaches of university courses, and to examine the philosophical credentials of the subject.

The reasons for the importance which the Russians gave to genetic theory are worth looking at. Ever since the Revolution the Russian Government has been engaged in trying to build up an economy strong enough to confer upon that country a degree of independence. In this endeavour time was considered to be a most important factor. It was believed likely that about twenty years was all that could be counted on before the onset of what was considered as the almost inevitable attack on the new regime by some Power or combination of Powers bent upon its destruction. As well as the building up of armaments and engineering works, it was felt necessary to increase the productivity of Soviet agriculture and horticulture so as to provide an increased food supply no longer based so largely upon the more vulnerable districts of the country. It was seen that genetics had an essential part to play in this programme. That is why, at a time when most of the world was burning coffee, destroying crops, and paying men not to produce, the Russian men of science were being asked urgently to increase yields. That is why the impact of genetics on a Russian was likely to be different from its impact on a citizen of another country.

It was because of the importance of the time factor that any offer of an increased speed in the production of desirable varieties of crop plants and of stock was so attractive to the people and Government of the U.S.S.R. The demand for speed led inevitably to the supply of offers, some honest and useful, some honest, ignorant and useless, and some, as in other countries, possibly to a considerable extent consciously fraudulent.

At the Conference the Russian geneticists who have made important contributions to genetic theory, among whom one of the well-known names is that of N. I. Vavilov, came into conflict with other workers, led by T. D. Lyssenko, who attacked certain of their conceptions. Some of these critics made it quite clear that they did not understand what it was that was being discussed. Others made real criticisms; often expressed in terms which make them most difficult to follow, but still real. The important criticisms were directed almost exclusively to three points, though they started from widely different fields and wandered about sometimes in a fatiguing manner.

The first real point of attack was the meaning, the reality and the interpretation of the Mendelian ratio of 3 : 1. Now, qualities resident in parents may appear in their descendants either never, sometimes, or always. If they never appear they are said not to be hereditary. If they appear always they are regarded as hereditary, but the mode of their inheritance would appear to defy analysis by familiar means. If, however, they appear sometimes, then the proportions in which they appear can be used as evidence about the mode of their inheritance. The conventional structure of genetic theory claims that the proportions in which heritable qualities appear are nearly always *sensible*. That is to say that they are regular in essence and that any apparent irregularity can be accounted for satisfactorily—can, in fact, be made sense of. This claim is coherent, and is based upon an immense body of observation and calculation. One of the simplest of these calculations leads to the expectation that a certain procedure in breeding will give descendants with certain qualities in the ratio of 3 : 1. Since this simple calculation is fundamental to the Mendelian concept its history is perhaps important.

Mendel noticed the proportions in which certain qualities in certain plants appeared in subsequent generations. He pointed out that in fact these proportions were those in which the qualities would be expected to appear if their appearance depended upon the distribution to the offspring of real physical entities present in the parents. To mediate the appearance of the qualities as observed, the entities would have to be present twice in the parents, to separate at the formation of the reproductive cells, and so to be present again twice, once from each parent, in the offspring. It was seen at the beginning of the century that chromosomes did behave and were distributed in a way analogous to this. Further work has shown that certain qualities in certain forms do depend upon the presence of certain parts of certain chromosomes. Mendel happened, it may be said by chance, to choose for investigation qualities which were mediated by factors present (in our terminology) on different chromosomes, or distributed as if they were, that is, practically at random with respect to each other by the crossing-over of chromatic material. If he had not done so he would presumably not have been able to make the generalizations which he did make.

If two parents are unlike in respect of one character in such a sense that in one both factors mediating it are similar, and in the other both are again similar to each other but different in state from those in the first parent, it can readily be seen that the mechanism described will give a first generation all alike and a second generation, derived by random mating in the first, in the proportions of one of each original type to two mixed. If one state of the factor permits the expression of the character if that factor is present only once, while in the other state the factor needs to be present twice, all the individuals will show the character except those which have the second state of the factor twice, once from each parent. This results in the second generation being in appearance three of one kind to one of the other. By an extension of the same argument, if two qualities are considered together the second generation will have four different appearances in the ratio 9 : 3 : 3 : 1.

Precisely these ratios are scarcely ever found in fact. Many things, such as differential death-rates, upset them. It was soon realized that the chromosomes were insufficient in number to account for the phenomena observed, and the factors were postulated as existing along the length of the chromosomes. They were called genes. The difficulty of expressing in terms of genes the heredity of such qualities as height, which can clearly vary continuously, soon made it necessary to consider the interaction of genes with each other, and such workers as Bridges and Timoféeff-Ressovsky were soon interpreting heredity in terms of the interaction of all, or at least many, of the genes with the environment. This enables genetic situations far less simple than those examined by Mendel to be analysed and expressed in Mendelian terms.

The critics at the Conference took the term "the 3 : 1 ratio" as standing for any of the ratios which would be given by such a mechanism as has been described, and in attacking it they were attacking this conception as a whole. They pointed out, what is well known, that these ratios are scarcely ever realized. They expressed this, in their very difficult terminology, by saying that the 3 : 1 ratio was a mathematical law, and not a biological law. Stated in ordinary terms this is simply the commonplace observation that many qualities which are hereditary have an inheritance mediated by many genes and not simply related to any one of them, and that many factors have to be considered as influencing the situation. If nothing is considered for the moment beyond the genes, it is clear that this means that the qualities will appear not in a simple 3 : 1 ratio but in a more or less complicated combination of such ratios, granting the whole Mendelian mechanism.

From this point the discussion really turns upon the question—a perfectly proper one—of whether the analysis of the inheritance of important qualities into terms which are likely to give so complicated a set of possibilities—almost as complicated as the animal one starts with—is really worth while. This question is not asked by Russians only. In Great Britain Hammond[3], among others, has recently suggested that the points which make a sheep good for killing are beyond useful analysis of this kind.

The fact is that animal- and plant-breeding are not the only customers that genetics has. Genetic theory has proved of immense value to the botanist and the zoologist engaged in constructing theories of evolutionary mechanics, where there is no hurry. Many papers on genetics are about its evolutionary aspects and the mathematics of inheritance in populations. Formal genetics, while it is used in much important work on many forms by many workers, has developed a side which is of little immediate use to the breeder. The reasons for this are fairly simple. The culture of Drosophila and the observation of populations are often based upon numbers which it would be inconvenient for the animal breeder to maintain if he were using cows. Some Russians believe that there "ought" to be a certain relationship between theory and practice, rather as some philosophers think there "ought" to be a certain relationship between, for example, what is said and the truth.

One cause of the distrust with which the Mendelians are sometimes regarded by some

breeders may perhaps have its roots in a misunderstanding of the claim by such workers as Muller that, in Drosophila, all heritable differences behave as Mendelian entities, or at least behave as they should do if they were dependent upon a number of these. Muller[4] mentions only one apparent exception, provisionally ascribed to the action of a virus. The breeder may sometimes feel the danger that this statement may be used to prejudge the nature of any instance of heredity in any form which may come up for discussion, and, worse, to belittle the successes of the breeder working with un-analysed material. It does not, for example, invalidate the truth of such well-authenticated observations as those of plastid inheritance in plants. The Mendelian behaviour of an inherited variation is a fact which has to be established for each variation. The formal geneticists feel strongly that, since about 1915, the onus is on the doubters to show that any case of inheritance is *not* Mendelian. Their opponents hold that until the mode of inheritance of any variation is known, it is formally inadmissible to presuppose one mode rather than another.

This questioning of the usefulness of the Mendelian analysis becomes involved with an attack on the logistic situation of formal genetics. Particulate genes, it is suggested, of a rather Lucretian atomicity, are invoked when convenient and, when inconvenient, are rendered almost unapproachable mathematically by an appeal to an ever more complicated system of interactions, only to reappear at the right moment. Perhaps partly because wheat is of great importance economically, it is in the discussion of the genetics of wheat that this second line was developed most clearly.

Wheat is normally a self-fertilizing plant. The widely used wheats to which names have been given have been produced by artificially crossing different strains. This is done by preventing self-fertilization and substituting pollen from a chosen source for that of the plant itself. The grains resulting are sown and the plants thus obtained are allowed to fertilize themselves in the ordinary way. If, now, the individual plants with the qualities desired in the new strain to be set up are alone allowed to survive, then as generation succeeds generation the variation in respect of these qualities grows less, because, in respect of the genes responsible for the mediation of these qualities the strain becomes more nearly homozygous—that is to say, the genes in question are present twice in an ever-increasing proportion of the population. The strain thus set up is called a pure line. It was pointed out long ago by Johannsen that the only variants to be found in a really pure line would be those due to environmental differences and so would not be inherited, apart from occasional mutants. Many of the strains of wheat set up by de Vilmorin in the middle of the last century are said to show no progressive changes since then[5].

Now, some of the Russian workers under Lyssenko claim to have produced strains of wheat by crossing within a previously recognized strain. If the strain in question is really a pure line this procedure of 'intra-varietal crossing' should be meaningless, and the wheats produced should be like their predecessors. The Russian workers claim that they are not. They claim that they differ, and that some of them are better than the wheats originally used.

They refuse to concern themselves with a full Mendelian analysis of the situation, holding it to be not worth while. The way in which the allegedly different qualities behave in heredity is therefore impossible at present to make out. Apart from accidental cross-pollination, the only thing that seems likely to change a really pure line, that is one that is really homozygous for the genes in question, is mutation. Wheats do mutate. If they did not it does not appear that they could evolve. It is conceivable that the Russians have obtained their alleged results by crossing plants which were not really homozygous for the genes concerned. But it must be borne in mind that through the breakage of the material of the chromosomes and other disturbing factors it is extremely difficult to get any individual pure, or homozygous, for *all genes*. It is, indeed, uncertain that such a thing has ever been done. It is here that a logical weakness in the structure of formal genetics is alleged. If all, or many, genes are relevant to any character, as they are assumed to be to account for other phenomena which are not easily accounted for otherwise, then, as more genes are reckoned in, the more improbable it is that any strain of wheat is homozygous for all the genes relevant to any quality, and the more meaning there is in 'intra-varietal crossing'. It should be remembered that the evidence for the persistence of qualities in de Vilmorin's wheats can in the nature of things only refer to qualities that can either be preserved dead for comparison year after year or else be precisely recorded. It is not evident that every single character of wheat, or even every useful one, falls into either of these categories. If the concept of the interaction of the genes is retained, as logically it seems that it must be, then any gene difference is relevant, and some would be possible between any two plants in a strain. In denying such a possibility the formal geneticist would be in a difficult position.

The third front of attack on the Mendelians at the Conference was much wider and much looser. There are certain technical procedures which can be carried out upon animals, and perhaps more upon

plants, which are useful inasmuch as they improve the plant or animal so treated. These procedures range from the commonplaces of agricultural and horticultural technique, such as seeing that the subjects are well nourished, to such bizarre performances as the grafting of a tomato on to a potato. Hammond, as well as discarding as useless the Mendelian analysis of the inheritance of some qualities in cattle, pigs and sheep, has emphasized the necessity of selecting stock for breeding in the best possible conditions of environment, including in particular those of diet. It may be doubted whether, in reality, these conditions contribute much more to the situation than that they enable the breeder to select those animals the genetic outfit of which permits them to take most advantage of good food. Selection in different conditions would produce different animals. Which is 'best' depends upon the available food and the humour of the market. If the environment of the selected animals is to be East Africa, a different procedure of selection will be proper from that which would be suitable if they are to be kept in Sussex.

If the effects of some of these technical procedures spread from the treated animals to their descendants either for a few generations or for ever, their value is evidently enhanced. The claim that they do is therefore tempting. It happens that the nature of the procedures and the nature of the material used in agricultural and horticultural practice make it far less easy to dispose of the claim that these effects do so spread than it is to dispose, for example, of the claim that the descendants of a mouse whose tail was cut off will have short tails. The two procedures which are of immediate importance in this connexion are vernalization and vegetative hybridization.

There does not appear to be anything particularly occult about vernalization. It has been found in Germany, and probably independently in the U.S.S.R., and confirmed in other countries, that if seed is moistened and warmed and then kept cold for some time and later sown, the seedlings grow faster than do those from seed not so treated. Some points about the process are beginning to be more or less understood. It has to do with the mobilization of food reserves in the seed, which mobilization is less checked by the cold than is the growth of the seed. When, then, the seed begins to grow after it has been sown, it has a more readily available supply of food material than if it had not received this treatment. The facts here seem fairly well established. They were greeted with considerable scepticism when they were first advanced.

It is claimed by Lyssenko and his associates that the effects of this treatment spread to generations subsequent to that treated. These workers, once more, refuse to engage in an analysis of the persistence they allege in terms of Mendelian inheritance. Such questions as whether the differences segregate they ignore. They are not interested. It may well be that they have not found anything in the least in conflict with orthodox genetics. While this state of deadlock persists, it is not easy to see how progress can be made. Each side in the argument considers that it has a set of terms in which the living universe makes sense. Each side believes that the other is childishly sensitive to what it mistakenly regards as an attack on an important and vital principle. The historian of science, with the centuries to draw on, will probably not find this situation unique.

The other procedure, that of so-called 'vegetative hybridization', once more raises the question of whether an effect does or does not spread to generations subsequent to that one which receives a particular treatment. Details of the procedures of grafting and the production of chimæras and 'vegetative hybrids', are given by W. Neilson Jones[6]. The chief facts are briefly these: in the ordinary way a scion grafted on to a stock grows under the influence of the stock and is affected by the qualities of the stock in various ways, probably partly, at any rate, through the sap which is shared. This is well known, and is recognized commercially in the selection of stocks suitable for different purposes. The relation between stock and scion may be of a more intimate nature. It occasionally happens that a bud with a mixture of cells derived partly from the scion and partly from the stock will grow from the region of the junction of the two. This bud gives rise to what is called a chimæra. The tissues may be related in different ways. Sometimes one tissue is on one side and the other on the other, and sometimes one is outside and the other inside. Finally, it has been claimed in the past that the relation may be of a still more intimate character, and that two nuclei, one derived from each source, may occasionally fuse as gametes fuse, and, with or without a subsequent reduction division, may give rise to a tissue the nuclei of which themselves contain a mixture of the contents of the nuclei of the two original plants, and are contained in a cytoplasmic environment strange to some of their genes. Such a plant, derived from the fusion of two vegetative nuclei, is called a 'vegetative hybrid' or 'burdo'. Whether such a plant has ever in fact existed is disputed.

The Russians under Lyssenko claim to have vegetative compounds of various kinds, the descendants of which display some of the mixed qualities. Yet again, they refuse to embark upon a Mendelian analysis of their material, holding it to be not worth while. At the Caxton Hall meeting of October 5,

Prof. J. B. S. Haldane suggested that some of the effects, if real, might be due to the transmission of something like a virus, as in the case of the recalcitrant Drosophila. It is a fact that some of the most striking examples claimed by the Russians are in the Solanaceæ, well known as the hosts of viruses sometimes with pseudo-hereditary effects.

While effects of this kind have been claimed in the past as occurring not infrequently, they may perhaps be considered to be rather rare on the whole. The Russians state that they have used large numbers in their experiments, and it may be that they have come upon an occurrence which has been overlooked in smaller numbers of subjects in work done elsewhere. No amount of appeal to other work can settle the Russian claim; only examination of the Russian material can do that. It is difficult at present to get a clear idea even of the simple facts of the chromosome situation of their plants.

It comes, then, to this. The followers of Lyssenko seem to the formal geneticist to be returning to the methods of the eighteenth century. This was suggested in NATURE in 1937[2]. But if the methods of breeders then were rule-of-thumb, they gave results which are, some of them, still to be seen. The followers of Lyssenko can retort that the formal geneticists are returning to the methods of the Middle Ages. It was believed then that stars moved in circles. If a star did not seem to be doing this very obviously it was considered proper to assume that the centre of the circle necessarily described in its path must itself be moving in a circle. This epicyclic method of explanation increases the complication of the situation it seeks to explain. This lack of economy is looked upon with disfavour. It affords a tempting refuge for the hard-pressed theoretician. Ptolemy is quoted[7] as having remarked, perhaps incautiously, that the phenomena could be saved by eccentrics and epicycles.

The phenomena do not need saving; they need investigating. It is suggested that now, in view of the recent tragic happenings in the U.S.S.R., many of the Russian varieties of plants and fruit-trees may be taken to Great Britain and the United States to be preserved from the invader. It is an irony of history that if this is done it will provide an opportunity for the analysis of the material when no one has time to do it.

[1] Report of the Conference on Genetics and Selection organized by the Editorial Board of the journal *Pod Znamenem Marxisma*. Translated for the Society for Cultural Relations, and available for consultation at its offices at 98 Gower Street, London, W.1.
[2] NATURE, 139, 143, 185, 1048 (1937).
[3] Hammond, J., "Farm Animals", London (1940).
[4] Muller, H. J., "The New Systematics". Ed. J. S. Huxley, Oxford (1940).
[5] Haldane, J. B. S., "The Causes of Evolution", London (1932).
[6] Neilson Jones, W., "Plant Chimaeras and Graft Hybrids", London (1934).
[7] Sarton, G., "Introduction to the History of Science", 2, Pt. 1., p. 16.

SURFACE CHEMISTRY

By Prof. W. D. Harkins
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One of the most interesting of the Fiftieth Anniversary Symposia, held at the University of Chicago during September 22–27, was that on two-dimensional systems or surface chemistry. Introductory remarks on the origin and development of this subject at the University were made by Dr. Irving Langmuir, Prof. H. I. Schlesinger, and Prof. W. D. Harkins. [It is interesting to note that this symposium was organized in honour of Prof. Harkins and the twenty-fifth anniversary of the publication of his first paper in the field of surface chemistry.—*Editors*.] Experimental work on the theory of molecular orientations in surfaces was begun in 1912 on the arrival of Prof. Harkins at the University. The first course of lectures on orientation was presented in the winter quarter of 1913–14. The gist of the theory is contained in a statement from the notes of George L. Clark taken during a lecture which dealt with the more tightly packed films of long-chain organic acids: "COOH of acid down because both acid and H_2O associated in polar." This is the earliest recorded statement of the direction of orientation of surface molecules.

In the first problem considered, but not the first to be solved, it was found that the adsorption of polar-nonpolar molecules is much higher at the surface of water than at the interface oil-water, as was predicted by the initial electrical field theory of orientation.

Interest in this problem arose in connexion with work in Karlsruhe in 1909 on Haber's theory of muscular motion, which assumed, as one of several steps, that a change from acid to basic causes a very great lowering of surface tension both in (1) the muscles, and in (2) a benzene-water system, with a strong acid and a strong base as solutes. However, experimental work proved that (2), assumed from work done in Berlin, is incorrect, so it was planned to substitute an organic acid. This gave Prof. Harkins the idea that at the benzene-water interface the hydrocarbon ends of

the molecules would dissolve in the oil phase and the polar groups in the water, but there was no opportunity to begin a test of this idea until 1912. Later an extensive search through the literature revealed the fact that in 1912 Sir William Hardy expressed the idea that the asymmetrical stray field at the surface of a liquid or a solid causes an orientation of the molecules.

While Hardy gave no evidence in favour of this idea, Harkins found evidence for orientation in Hardy's values for the work of adhesion (W_A) between water and other liquids. Since this evidence was made somewhat uncertain by the inaccuracy in the drop weight method used by Hardy, a considerable amount of experimentation was carried out by Humphery, Brown and Davies, in order to give a high degree of accuracy to the method. This was the more necessary on account of the fact that the internal (surface) energy (E) is much more intimately related to the molecular orientation than is the free surface energy (F), and the determination of E involves the entropy, that is, the slope $(\partial\gamma/\partial T)_{p,\sigma}$, where σ equals molecular area.

Even at the present time one of the best lines of evidence for the orientation of molecules in interfaces is given by the values of W_A, and especially of E_A, at the liquid-liquid, and at the solid-liquid interface. For example, the energy E_C in erg.cm.$^{-2}$ required to pull n-octane apart is 100, while for n-octyl alcohol it is only 101, showing that the polar group has almost no effect, since the molecules orient so that only the non-polar hydrocarbon groups are pulled apart. To pull n-octane from water requires an energy of 107, but to pull n-octyl alcohol from water a much higher energy is needed (165), since the polar group must be separated from the water.

In recent work with Dr. G. E. Boyd the relative energies of immersion (E_I) of TiO_2 (anatase) are found to be: water, 1·00; butyric acid, 0·77; ethyl acetate, 0·69; butyl alcohol, 0·67; nitrobenzene, 0·55; carbon tetrachloride, 0·46; benzene, 0·28; iso-octane, 0·20, and these ratios are practically the same for the solids, which give the following values of the total *energy of adhesion* (E_A) in erg.cm.$^{-2}$: $BaSO_4$, 490; TiO_2, 520; SiO_2, 600; ZrO_2, 600; SnO_2, 680, and $ZrSiO_4$, 850, graphite 265. Graphite, however, exhibits abnormal values of the ratio, namely, 0·73 for CCl_4 and 0·85 for benzene. All the crystalline solids (except graphite) are found to be much more polar than water and the polar groups are turned towards the solid.

Values obtained by the adsorption of four vapours by H. K. Livingston show that all give the same area for any particular solid, provided the areas per molecule in the completed first monolayer are taken as: nitrogen, 15·4; water, 10·6; propyl alcohol, 20·0; and n-heptane, 55·0 A^2. The last value shows that in the completed monolayer *n-hydrocarbon molecules lie flat on the surface.*

In his paper on the properties of solid surfaces, Dr. Boyd gave examples of the *free energy of adhesion* between a solid and various liquids. With TiO_2 the values are: water, 380; propyl alcohol, 129; and n-heptane, 78. The corresponding values of $\gamma_S - \gamma_{SV_0}$ (energy of immersion in the saturated vapour) are 240, 82 and 38 erg.cm.$^{-2}$ for the clean surface of anatase. The values were calculated from the vapour adsorption isotherms obtained by Livingston and the proper Gibbs's adsorption equation.

Dr. Fritz London, of Duke University, considered the centres of van der Waals' attraction. A special type of long-range attraction is assumed to act between large molecules where the virtual electron oscillators are of appreciable extension.

If a molecule possesses considerable electrical anisotropy in its parts (as in the chemical bonds), it is no longer permissible to use the dispersion force as a central force, but rather specific formulæ must be employed. For example, the interaction energy between two anisotropic force centres (bond ellipsoids) is:

$$E_{\mathrm{I,II}} = -\frac{1}{R^6}[A - B - B' + C\,(\sin\delta\sin\delta'\cos\varphi - 2\cos\delta\cos\delta')^2 + 3\,(B - C)\cos^2\delta + 3\,(B' - C)\cos\delta' + B + B' + 4C],$$

where R is the distance between the centres I and II, $\alpha_{\parallel}\alpha_{\perp}$ and $\alpha'_{\parallel}$, $\alpha'_{\perp}$ the components of their polarizabilities, respectively, $\bar{\nu}_{\parallel}$, $\bar{\nu}_{\perp}$ and $\bar{\nu}_{\parallel}$, $\bar{\nu}_{\perp}$ the corresponding frequencies, δ, δ', the slopes of the two bond directions with respect to the line joining the centres, and φ the angle between the projections of the two bond axes into a plane perpendicular to the joining line.

In the special case where the interaction energy between large oscillators is desired for distances shorter than the spacial extension of the interacting virtual charge distributions of the molecules, it was found desirable to represent each oscillator by several distinct poles, 'monopoles', of different sign, suitably located in the molecule. As a consequence of the quantum mechanical treatment of the problem in these terms a new formula for the energy of interaction is reached:

$$E^{(2)} = \frac{\varepsilon^2\varepsilon'^2}{h\,(\nu + \nu')}\left[\frac{1}{R_{++}} + \frac{1}{R_{--}} - \frac{1}{R_{+-}} - \frac{1}{R_{-+}}\right]^2$$

where R_{++}, R_{--}, R_{+-}, R_{-+} symbolize the distance of separation of the respective monopoles; ε, ε' give the magnitude of the high-frequency dipoles.

The theory should be useful for systems containing conjugated double bonds, of which rubber is an example, and for large biological molecules.

Prof. J. G. Kirkwood, of Cornell University, discussed the theory of the transition expanded to the intermediate liquid phase. This transition is considered as an order-disorder transformation in axial orientation of the molecules which constitute the film. By postulating a free energy barrier of appropriate form, which hinders the relative axial rotation of neighbouring molecules, Kirkwood is able to demonstrate a phase change of the second order in a *model* film of cylindrical molecules of elliptical cross-section vertically oriented on the subphase. By means of the statistical mechanical theory of co-operative phenomena the magnitude of the discontinuities in the heat capacity, the coefficients of thermal expansion and compressibility attending the transition, have been calculated. These agree well with the experimental values of Harkins, Young and Boyd.

Surface entropy of pure liquids was dealt with in a paper by Mr. Henry Eyring of Princeton University.

A relation between free surface energy (A_S) and the Eötiös equation is:

$$A_S = E_S - TS_S = N^{1/3}\, V^{2/3} = 4{\cdot}4\,(T_C - T - 6)$$

The entropy, 4·4 Cal. mole^{-1} deg.$^{-1}$ arises from expansion of the surface region, the free energy of which can be estimated by the partition function of normal liquids (Walter and Eyring). The final equation is $\gamma = (\rho_L - \rho_V)\,(a - bT)$ where $a/b \sim T_C$.

Remarkable electron microscopophotographs of gas carbon, bacteria and the coatings of insects were presented by Prof. E. F. Burton, of the University of Toronto, the pioneer in this field in America.

Dr. George H. A. Clowes, research director of Eli Lilly and Co., described the interactions of biologically significant substances.

From extremely extensive data it is shown that many carcinogenic polycyclic hydrocarbons are highly soluble in sterol monolayers (10-methyl-1-2 benzanthracene in cholesterol), in which case the logarithm of the mol fraction of the hydrocarbon varies linearly with film pressure (π). A complex of one molecule of hydrocarbon to two of sterol forms with a free energy of 2·5 kilocalories or less. Increase of pressure on a two-dimensional solution may force the hydrocarbon into colloidal solution in the subphase. Such material penetrates the film at lower pressures. The relations to biology were discussed.

The intrinsic viscosities and the reciprocals of the frictional ratio of fifteen globular proteins were compared by Prof. Henry B. Bull and Mr. J. A. Cooper, of Northwestern University, and an empirical, linear relation found to exist between them. This empirical relation was used to estimate the average volume hydration, which was found to be 0·283 c.c. per c.c. of dry protein, with a standard deviation of the mean of 0·042 c.c.

A test applied to several theoretical equations in the literature relating viscosity and asymmetry of suspended particles is based upon the empirical linear relation between viscosities and reciprocals of the frictional ratios of the protein molecules. None of the theoretical viscosity equations are valid when applied to protein solutions.

Increase of surface tension (γ) by highly polar organic compounds was the subject of a paper by Prof. Ernst A. Hauser, of the Massachusetts Institute of Technology, and Mr. Adrian J. Grossman.

The increments of surface tension produced in benzene by a 0·5 mole fraction at 40° of dinitrobenzenes are: *ortho* 1·75 (6·05), *meta* 1·3 (3·81), *para* 1·2 (0·32), in dyne cm.$^{-1}$, where the values in parentheses are the dipole moments. Thus the increments in γ are related more intimately to the high bond moment (3·9) of the nitro group than to the molecular moment. Frequent changes in the slope $(\delta\gamma/\delta C)_{T,p}$ were found, and a deep depression of 1·2 dyne cm.$^{-2}$ was obtained with 1-nitronaphthalene.

Mr. Eugene Guth, of the University of Notre Dame, considered stress and elasticity in rubber. The theory presented on the basis of an ideal model of incompressible rubber considers an irregular network of flexible long-chain molecules, and predicts the characteristic S-shaped stress-strain curves found in experiments on an unaccelerated pure gum compound. In the analytical expression for the theoretical curves, the Langevin function of the theory of paramagnetism, or the Debye theory of dipole molecules, enters and describes the orientation of the long molecules due to the applied stress.

It is found:

(1) That the stress is due largely to the kinetic energy (entropy) of the molecules and not to the intermolecular forces, since the latter are found to contribute only about 20 per cent of the stress.

(2) As predicted by the theory the stress at constant length is proportional to the absolute temperature.

(3) The slope of the stress-temperature curves is negative up to 10 per cent extension and is positive above this, due to thermal expansion.

(4) Since the heat developed in adiabatic stretching is proportional to the temperature coefficient of the stress (Kelvin-Joule), heat is absorbed for 0 – 10 per cent extension, and is given off for greater extensions.

A new superliquid phase was described by Prof. W. D. Harkins, Copeland and G. E. Boyd.

At certain temperatures it is found that the condensed liquid (L_2) phase of a long-chain alcohol

on increase of pressure transforms by a *first order* change into a new LS phase, which has the compressibility of the solid phase, but exhibits a greatly lowered viscosity compared with that of the liquid from which it is formed by compression and the addition of heat. The internal energy increase and the increase of entropy when this phase expands are excessively large. In the transformation of the L_2 to the solid S phase there is no latent heat, so the change is second order.

Mr. Eyring considered the viscosity of monolayers from the theory of absolute reaction rates.

A decrease in viscosity with increase in pressure indicates that the activated state occupies a smaller area than the initial state, and vice versa. Similarly a decrease in viscosity with temperature indicates that the activated state has a greater energy than the initial state; and increase in viscosity with temperature that the activated has less energy than the normal state.

A thermodynamical theory of the spreading of liquids on surfaces was presented by Prof. Harkins.

(1) A duplex (D) or thick film may spread if its spreading involves a decrease of free energy. On water a D film is always unstable, since there is a decrease of free energy when it transforms into a monolayer (M) and a lens.

(2) Water and all oils spread on mercury, and all liquid oils on water to give monolayers, but if a duplex film cannot spread the pressure (π) of the monolayer may be small.

(3) $\pi_e = S_{b'/a} - S_{b'/a'}$ or the semi-initial minus the final spreading coefficient. Since $S_{b'/a}$ is always negative, π_e, the equilibrium pressure, is always greater than the semi-initial spreading coefficient, and almost always greater than $S_{b/a}$, the initial coefficient for the spreading of the dry oil (b) on clean water (a) as a duplex film.

(4) Water does not spread as a duplex film on any oil.

(5) It always takes *less* work to pull any oil from its first complete monolayer on water than to pull the oil apart.

(6) While lower hydrocarbons give duplex film spreading on water, higher hydrocarbons and some polar oils (as methylene iodide) do not, but form monolayers only.

Dr. Irving Langmuir, of the General Electric Co., discussed the permeability of monolayers.

Copper gauze supporting a layer of $CaCl_2 \cdot aH_2O$, mounted at a distance b above the surface of water in a film trough is used to measure the rate of evaporation. At equilibrium, the rate at which water escapes is determined by the resistance of the moisture-saturated air in the space between the liquid surface and the adsorbent. This resistance to diffusion, ω, is given by $\omega = Awt/M = b/D$, where A is the surface area evaporating, w the grams of water per unit volume of saturated air, t the time in seconds, and M the mass evaporated; D is the diffusion coefficient. A monomolecular film of an acid, alcohol, cholesterol or ergosterol placed on a clean water surface gives an increase in ω, but proteins do not. A logarithmic relation is found between ω and the film pressure. The permeability exhibits extreme sensitivity to impurities. Langmuir considers an impermeable film to be tightly packed at some *definite height in the film.*

NEWS AND VIEWS

In Defence of Liberty

LAST week, on the outbreak of war between the United States and the Totalitarian Powers, the King sent a message to President Roosevelt, which concluded with the words: "We share your inflexible determination and your confidence that, with God's help, the powers of darkness will be overcome and the four freedoms established throughout a world purged of tyranny." President Roosevelt, in his reply, paid a tribute to the courage of the British people during the past two years, and said: "The forces which have plunged the world in war, however strong, cannot prevail against the indomitable strength of free peoples fighting in a just cause."

This was also the text of President Roosevelt's stirring radio address to the American peoples on December 15, the one hundred and fiftieth anniversary of the adoption by Congress of the Bill of Rights The basic principles of the freedom of man embodied in the Bill have been accepted by all the republics of the Western hemisphere, and indeed by some four fifths of the peoples of the world. The present struggle is nothing less than an attempt on the part of the Totalitarian Powers to overthrow all the results that have flowed from the gradual growth of the liberty of the individual. It is an attempt to impose once more on mankind the tyranny and despotic rule of the Middle Ages, from which we have been set free by the courage and sacrifice of our ancestors. The present generation of Americans, President Roosevelt said, are as determined to preserve liberty as their ancestors were to win it, and he pledged Americans not to lay down the arms they have now taken up until liberty is once more secure in the world.

The Central Register

In reply to a question asked by Sir Herbert Williams, the Minister of Labour and National Service stated in the House of Commons on December 11 that as soon as the necessary arrangements can be made, the present Central and Supplementary Registers are to be merged in a new Appointments Department of the Ministry of Labour and National Service. This new department will deal with persons possessing specified administrative, managerial, professional, or technical qualifications and with others who, though not possessing specific qualifications, have a normal salary in excess of £420 per annum. It will operate through its staff at headquarters or through staff under the control of the Regional Controllers, according to the nature of the vacancies for candidates. It will maintain a separate register of persons within its scope who are known to be seeking an engagement and will endeavour to find suitable employment for such persons in some form of national service. The provincial organization of the department will be closely associated with the new district man-power boards.

Gas-producer Poisoning in Sweden

According to the October issue of the *Anglo-Swedish Review*, medicine and technology in Sweden are collaborating in the problem of poisoning from gas-producers, with the result of the establishment of the first clinic in the north at the Sabbatsberg Hospital in Stockholm. The work is being conducted on the following lines: (1) Examination in the laboratory of specimens of blood for carbon monoxide content. Up to the present 4,300 analyses have been made. (2) A clinic of ten beds has been set up and an out-patient department where over 700 cases have been examined. (3) Physiological examinations are being made to discover the most suitable form of treatment and the proportion of chronic cases. (4) Examination of the cerebrospinal fluid in patients who have died from asphyxia is being carried out. The experiments are being made on human volunteers and on porpoises and rats.

Use of Pitch as Fuel

It is well known that modern life in peace and especially in war depends on fuel in liquid form. While consumption of the lighter and more volatile fuels in internal combustion engines is more apparent to the layman, there is a large consumption of heavier fuel oils consumed for industrial furnaces and on board ships. In peace-time practically all the supply of such heavy oils used in Great Britain were imported and a relatively low price was efficiently maintained. Indeed, industry was furnished with a fuel often superior in quality to what was essential to the purpose in question. The reduction in available supplies of imported oil has compelled the use of heavier and lower grade petroleum oils and indigenous materials such as cresote and pitch-creosote blends.

An interesting development is the use of coal tar pitch itself, both solid—as pulverized pitch—and liquid—as molten pitch. Such materials find their application particularly where consumption is large and continuous—for example, in steam boilers and large furnaces. The fuel has certain attractive properties—low sulphur content, freedom from ash and water, uniformity in quality and calorific value. For use it must be heated to 200°C. and conveyed in pipes to the furnaces at this temperature. This has produced unusual engineering problems, the solution of which has required great skill, because the consequences of failure are serious, if ever the pitch solidifies in the mains. The plant used for this purpose was described at a meeting of the Institute of Fuel in London on October 30. This is a valuable technical achievement, because production of pitch has for years exceeded demand and there is in stock a very large quantity which can replace much petroleum oil formerly employed.

Standardization in the Electrical Industry

A thoughtful address was delivered on October 27 by Mr. H. G. Taylor, chairman of the Liverpool Centre of the Institution of Electrical Engineers, on "Co-ordination and Standardization". He regards co-ordination as the best means of arriving at standardization. He said it would be disastrous if the end of the War found engineers unprepared to face the problems of peace in a changed world. Immediately after the War of 1914–18, a major happening in the history of the electrical supply industry in Great Britain was the appointment by the Board of Trade of the Electricity Commissioners as a technical body under the chairmanship of Sir John Snell. As a result of their investigations and in conjunction with the Weir Committee, the Central Electricity Board was established in 1926, its function being to supply electricity in bulk to various distributors and concurrently to increase the availability of supply. This entailed co-ordinating the existing supply authorities, their personnel and plant, while the question of interconnexion of plant involved standardization of frequency, the necessity of which Sir John Snell foresaw, and powers to enforce a national standard of 50 cycles were consequently included in the Act of 1926. As a theory, standardization in electrical engineering is almost as old as the science itself, but its application in Great Britain has lagged too far behind technical progress to maintain a healthy condition in the industry, the development of the heavier engineering commodities having continued, for the most part, on individual lines.

The recognized centre now for dealing with standardization is the British Standards Institution, which now has more than a thousand committees, with about six thousand professional men who have given their time freely to this national work. It is an independent body in close touch with industrial requirements and modern technical knowledge, with the fullest Government support but free from Government control. It co-operates with the central standardization bodies in various parts of the British Commonwealth of Nations, and participates, directly or indirectly, in the work of international standardization.

After the War, we must produce for export not the apparatus which other countries rightly wished to manufacture themselves, but commodities in which we have the technical ability to make ourselves supreme. By complete co-ordination of industrial organizations and research establishments electrical engineers can assist very materially, and the adoption of international standards must be considered. Mr. Taylor suggested uniformity of design for utility electrical products in common use both in the industrial and domestic fields. Such a standard, to be effective, would need to have behind it the authority of the British Standards Institution, and its adoption might even need legislative action. Manufacturers would be encouraged to adopt these standard commodities as their first line of production, and in consequence they would ultimately replace the many specialized products now on the market.

Arterial Road Lighting

THE arterial road connecting Toronto and Niagara Falls, known as Queen Elizabeth Way, is lighted by incandescent lamps in parallel over its whole length of 70 miles. Already the lighting installation enjoys the distinction of being the longest in the world, and no doubt it will be continued on the proposed 20-mile extension of the highway to Fort Erie, making a total of 90 miles. In planning the installation provision was made for maximum silhouetting of obstacles. The Way consists of dual concrete tracks 20–23 ft. in width with an intervening strip of grass 28–30 ft. wide; the standard equipment comprises wooden poles, along the centre line of the grass, with welded cross-arms overhanging each traffic lane to the extent of 3 ft. The availability of cheap electric power from existing rural circuits operated by the Hydro-Electric Power Commission of Ontario seems to have been a determining factor in the adoption of incandescent lighting and parallel distribution. Sodium lamps are used to mark intersections. Distribution transformers of 15-kva. capacity feed the 115-v. lighting cables from the 2,300-v. rural distribution network. The lamps are of 6,000 lumens, 400 watts, spaced 200 ft. apart, and maintenance is by group replacement twice a year. Operating experience and costs from this installation should be of material assistance in planning the general lighting of arterial roads.

Discovery of Smithfield Industries in Kenya

THE September–October number of *Man* contains a letter which is of distinct importance to those who concern themselves with the problems of Stone Age Africa. It would seem certain that Archdeacon Owen has discovered in a rock-shelter in Kenya an early Smithfield industry, and that Prof. van Riet Lowe has agreed with his interpretation. Smithfield industries occur over large parts of South Africa, especially in the Free State, the material used for their manufacture being usually the local indurated shale which chips well. Scrapers, awls, beads, and occasionally a little pottery have been found. The range in time of the culture extends backwards from modern days to an unknown, but probably fairly remote, period, as the later Smithfield industries show differences when compared with the earlier ones. Thus the plano-convex knife is an early tool type and does not recur in the more recent finds, while pottery seems to be absent from the earlier ones. In South Africa, too, there are regional differences in the industries which add to their complexity. But the main great problem has always been as to whether the Smithfield culture as a whole was an autochthonous growth in South Africa itself, engendered perhaps by culture-contacts; or whether it was not rather introduced into the subcontinent by migrations from the north. Archdeacon Owen's new discovery of Early Smithfield material—considered in fact to be even somewhat older than the Early Smithfield of South Africa —in Kenya would suggest that the latter hypothesis is the correct one.

Folk-lore of Alcoholism

IN a paper on this subject (*Brit. J. Inebriety*, July–October), Dr. J. D. Rolleston remarks that with the exception of Hovorka and Kronfeld's great work on comparative folk medicine no writers have dwelt at length on folk-lore in relation to alcoholism. He has therefore collected the folk-lore of this condition, as he has recently done in the case of general medicine, dermatology and pulmonary tuberculosis. His paper deals with the nomenclature, popular phraseology, superstitions and leechcraft connected with alcoholism and alcohol, the term 'leechcraft' being that commonly employed in the language of folk-lore to indicate popular methods of prevention and treatment. In a previous paper on "Alcoholism in Classical Antiquity" (*Brit. J. Inebriety*, 24, 101; 1927) he directed attention to the numerous synonyms for inebriated or bibulous persons, both in Greek and Latin, as well as in English, which contained about seventy such terms, only a minority of which could be called slang, whereas there are more than 280 slang synonyms for the word 'drink', 160 for the verb 'to drink', and 150 for various forms of intoxication. Popular interest in the consumption of alcohol, especially in excess, was further demonstrated by the great variety of similes connected with the subject. After dealing with the superstitions and popular errors connected with alcohol and alcoholism, which are legion, Dr. Rolleston discusses the popular methods of prevention and cure for inebriety, which he classifies under the headings of animal remedies, including coprotherapy, plant remedies, of which a large proportion are mentioned by Pliny, mineral remedies, invocation of patron saints and water.

Tuberculosis and War

ACCORDING to an editorial in the August issue of the *Statistical Bulletin* of New York, tuberculosis is already on the increase in other countries than the United States, although the evidence is based only on provisional or fragmentary data. In England and Wales the death-rate among male civilians rose slightly in 1939 and in 1940 in both sexes. For males the death-rate from tuberculosis rose 13 per cent

between 1939 and 1940 from 77·1 per 100,000 to 87·4; for females the increase was 7 per cent from 50·9 to 54·7. In Scotland the deaths from tuberculosis in 1940 increased 14 per cent over 1939, and the death-rate in 1940 was the highest since 1932. In Canada the mortality from tuberculosis did not rise in 1940, but there was a significant increase for the first half of 1941. In Germany and the occupied countries statistics on tuberculosis are not available. As regards France, a sharp increase in the disease has been reported from Vichy. The longer the War lasts and the farther it extends the greater will be the increase in tuberculosis, as is shown by the War of 1914–18, particularly among the women and children in Germany, Belgium, and eastern and south-eastern Europe, and to a less degree among the neutral countries.

Prevention of Typhus Fever

AT a meeting of the Section of Epidemiology and State Medicine of the Royal Society of Medicine on November 28, Dr. Melville D. Mackenzie read a paper on the control of louse-borne typhus fever in Great Britain in the light of experience in Russia, Poland, Rumania and China. After discussing the epidemiological relationship of the disease to movements of population, under-nourishment and climatic conditions, he dealt with the rapidity of the spread of typhus fever, the frequency with which it is associated with other diseases and other factors which might complicate diagnosis, the method of infection, the importance of improved nutrition in the control of an epidemic, the value of reducing the number of lice in the population generally in addition to the tracing and delousing of contacts, the possible importance of dried fæces in the spread of the disease and the danger of the first cases being overlooked. Stress was laid on the necessity of utilizing young personnel in anti-typhus work. The greatest importance was attributed to the necessity for the thorough disinfestation of patients and contacts, the premises and their contents, as well as of the ambulance and the staff after duty.

The National Institute for Research in Dairying

THE report of the National Institute for Research in Dairying (University of Reading) for the year ended September 30, 1940, has just been published. Many members of the staff are now acting in an advisory capacity on various war-time committees appointed by the Government, especially the Ministry of Agriculture. The realization of the essential need for milk to balance the deficiencies of a war-time dietary and the multifarious problems that this involves is, of course, making demands on the work of the staff and thus a number of long-range research projects have been shelved in order that the staff may devote more time to advisory work and short-range investigations of war-time problems of the dairy industry. Details of the work of the various departments of the Institute, namely, dairy husbandry, chemistry, bacteriology, dairy bacteriology advisory, physiology and biochemistry, and of the experimental dairy are included in the report. Sixty-six research papers were published by various members of the staff during the year, and as usual a separate list of papers which can be supplied by the Librarian is appended. This latter list contains twenty-nine titles. The address of the Institute is Shinfield, near Reading, Berks.

Country-Side

THE first number of the war-time issue of *Country-Side*, the quarterly journal of the British Empire Naturalists' Association, has appeared to start the twelfth volume of this well-known journal. It is edited by Mr. Leslie Beckett, the honorary organizing secretary, and comprises a twenty-page octavo issue containing five original papers, a number of smaller notes and lists of regional field records on birds, insects and fungi. There is a list of twenty-one local branches of the British Empire Naturalists' Association (including a new one at Bath) which are remaining active during war-time. Mr. J. W. Bradley has a short article on the birds of Burma, Mr. E. L. Swann describes the formation of a Norfolk salt marsh and its subsequent flora, and Mr. M. B. B. Heath some recent observations of Mars. Among smaller notes there is an account of *sotto voce* song in the hen blackbird, the timing of the reeling song of the grasshopper-warbler to vary from 20 to 65 seconds with stops of 4–20 seconds between; Captain T. Dannreuther describes the immigration of clouded yellow butterflies to Great Britain in 1941. Mr. A. H. Wolley-Dod correlates the rarity of autumn bird song with the dry season, and there is a note on the abundance of privet hawk moth larvæ, even in London, this autumn. Field records include the wood-sandpiper, ruff, shelduck and gadwall at Cambridge sewage farm, the autumn passage of white wagtails in Lancashire, and October song of the blackbird in Wiltshire, where the speckled wood and comma butterflies were very numerous all the season.

Horticultural History

THREE papers in recent numbers of the *Journal of the Royal Horticultural Society* describe the history of gardens and gardeners of the past. The gardens at Wormley Bury, Broxbourne, Herts, have been the means of introducing many new plants to the horticulture of Britain. Sir Abraham and Lady Amelia Hume introduced many species between 1785 and 1825, including several notable Amaryllids, two species of Pæonia, *Rudbeckia pinnata* and *Humea elegans*, named after the introducers. Major Albert Pam writes the article (66, Pt. 9, Sept., 1941), and is himself the present owner of Wormley Bury. The other two papers (66, Pts. 9 and 10, Sept. and Oct., 1941) are by the assistant secretary of the Society, and deal with the activities of William Forsyth in founding the Royal Horticultural Society. Forsyth's memory is maintained in the genus Forsythia which Vahl named in his honour, but he also experimented upon the treatment of wounded trees by covering the cut portions to exclude harmful fungi. He made useful contributions in this connexion, but clouded them so with extravagant claims that the benefit came to be largely discountenanced.

Portland Cement Industry of the United States

STATISTICS relating to the Portland cement industry of the United States, compiled by the U.S. Bureau of Mines, show that the quantity of this substance produced in 1940 was 130,216,511 barrels (the unit of measure employed throughout the statistics is the barrel of 376 lb.). The output for 1940 is not only 7 per cent higher than the output for 1939 but also was the largest quantity manufactured since 1930. Nevertheless, the output for 1940 was less by 20 per cent than that for 1928, which still constitutes the peak year of production. Basing their figures on the quantities of cement dispatched from works into the various States of the Union, aggregating nearly 127,800,600 barrels, it is estimated that the annual *per capita* consumption of cement averaged 0·96 barrel (about 3 cwt.) in the whole of the United States in 1940, as compared with 0·94 barrel in 1939. These figures represent only the records of the consignments inside the country. During 1940, 80·9 per cent of the Portland cement dispatched from works in the United States was moved by railway, 15·6 per cent by motor lorry and 2·2 per cent by boat. Furthermore, 25·6 per cent of the cement was dispatched loose, in bulk, 42·4 per cent was packed in paper bags, 31·9 per cent in cloth bags, and 0·1 per cent in other containers, including steel drums and iron or wooden barrels.

Imports of hydraulic cements into the U.S. in 1940 totalled 91,000 tons, compared with 321,000 tons in 1939. In both years the chief supplying country was Belgium and the second was Denmark. In spite of its large annual cement production, the export trade of the United States is small, totalling in 1940 a little more than 1 per cent of the production. The exports for 1940, however, which totalled nearly 284,000 tons, were higher than in any other recent year. Of the 1940 exports, 206,000 tons were dispatched to various countries on the North American Continent, the Central American Republics, the West Indies and Canada. The largest quantity was consigned to the Panama Canal Zone, namely, 82,000 tons. According to *Engineering* of September 26, South American countries imported in 1940, 73,400 tons of cement from the United States, Europe merely 76 tons, Asia 1,320 tons, Africa 2,390 tons and Oceania 70 tons; 248,500 tons of cement were shipped to Alaska, Hawaii, Puerto Rico and other outlying territories of the United States.

Animal Production and Veterinary Science Abstracts

To meet the requirements of those engaged in the animal industries, a new section of *Biological Abstracts*, to be known as "Section F, Abstracts of Animal Production and Veterinary Science", will begin in January next. It will contain all the abstracts published in *Biological Abstracts* that have to do with the breeding, nutrition and metabolism, husbandry, reproductive and other physiology, anatomy, pathology and parasitology, and arthropod pests of livestock, poultry and semi-domesticated animals and birds, including pet stock. The new section will consist of ten abstract issues a year. The annual subscription rate will be 5 dollars, and subscribers will receive the index to the complete edition of *Biological Abstracts*. *Biological Abstracts* now covers some 1,450 periodicals, so the new section will, from the beginning, afford a very complete survey of the biological literature pertaining to the animal industries. Inquiries should be addressed to *Biological Abstracts*, University of Pennsylvania, Philadelphia.

Announcements

PROF. EMILE PICARD, For. Mem. R.S., permanent secretary of the Paris Academy of Sciences and a distinguished mathematician, died on December 12, aged eighty-five.

The Symons Gold Medal for 1942 of the Royal Meteorological Society has been awarded to the late Dr. J. S. Owens, whose death occurred on December 6. This Medal is awarded biennially for distinguished work in connexion with meteorological science. The presentation will be made at the annual general meeting of the Society on January 21 next.

DR. R. B. McConnell, assistant field geologist, has been appointed geologist of the Lands and Mines Department, Tanganyika.

DR. ORLANDO PARK, Northwestern University, will in future edit the "General Animal Ecology" Section in *Biological Abstracts*, thus succeeding Dr. W. C. Allee. The "Speciation" Section will be edited by Dr. Alfred Emerson, of the University of Chicago.

THE title of professor emeritus of logic and scientific method in the University of London has been conferred on Dr. A. Wolf, on his retirement from the professorship of logic and scientific method at University College and the London School of Economics.

PROF. HERMANN STEUDEL, emeritus professor and director of the Institute of Chemical Physiology at Berlin, has been awarded the Goethe Medal for Art and Science on the occasion of his seventieth birthday.

THE Financial Secretary to the Treasury stated on December 11 in reply to a question in the House of Commons that the number of students at universities and university colleges in Great Britain during the past autumn was approximately 25,000, of whom 5,900 were grouped as taking arts subjects and 19,100 scientific, technical and medical subjects.

MR. R. J. FLINTOFF, of Goathland, Yorks, founder of the Northern Ecological Society (see NATURE, December 13, p. 722) bequeathed his notebooks on plants to the British Museum; £1,000 to the Linnean Society of London for a medal; £1,000 to the Chemical Society for a medal; and £1,000 to the University of Manchester for a prize; he also made provision for the publication of his researches.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Names of Electrical Units

WHILE the use of the metre-kilogram-second-coulomb system of units is rapidly becoming more widespread, that of the E.M.U. system is almost non-existent, except in elementary courses and old-fashioned text-books. In purely electrostatic problems, on the other hand, the general use of the E.S.U. system is likely to continue. The lack of distinctive names for the units in this system is a drawback in several respects, of which I will only mention the difficulty of checking dimensions. To remedy this defect a practice has arisen of using names such as 'statcoulombs', 'statvolts' and other equally cacophonous terms. This nomenclature has already been criticized in a recent review of a text-book (*Proc. Phys. Soc.*, **53**, 624; 1941), but no alternative has been proposed. I therefore wish to propose a terminology which should be acceptable to all English-speaking people.

I suggest that the charge which repels a similar charge at a distance of one centimetre with a force of one dyne be called a *franklin*, in honour of Benjamin Franklin, the pioneer of static electricity.

There is no need for any other new names. The accompanying table gives the units of the most important electrostatic quantities in centimetre-gram-second-franklin (C.G.S.F.) units and in metre-kilogram-second-coulomb (M.K.S.C.) units. It seems unlikely that one should want to use the C.G.S.F. system for magnetic measurements, but it can be so used; the unit of H would be franklin/sec. cm. and that of B would be erg cm. sec./franklin.

At the same time, to avoid ambiguity, I suggest that, whatever units be used, the ratio D/E should always be called the *permittivity*, a nomenclature already widely used in the United States, and that *dielectric constant* should denote the ratio of permittivity of medium to that of empty space and should thus be a number independent of the units used. This suggestion is incorporated in the table.

One further point. An increasing number of physicists, though still a minority in Great Britain, prefer to use the rational system. I want to point out that this need not involve a change of units, but merely a change in the definition of D, so that at the surface of a charged conductor, $D = \sigma$ instead of $D = 4\pi\sigma$, and the electrostatic energy density becomes $\frac{1}{2}ED$ instead of $ED/8\pi$. Rationalization thus leaves E unaltered, but reduces D by a factor $1/4\pi$, and this statement is true whether E, D be both measured in C.G.S.F. units or both in M.K.S.C. units.

E. A. GUGGENHEIM.

Term	C.G.S.F. unit (E.S.U.)	M.K.S.C. unit
Charge	franklin	coulomb
Surface density of charge, σ	franklin/cm.²	coulomb/m.²
Displacement, D	franklin/cm.²	coulomb/m.²
Current	franklin/sec.	coulomb/sec. = amp.
Current density	franklin/sec.cm.²	amp./m.²
Energy	erg	joule
Energy density	erg/cm³.	joule/m³.
Potential	erg/franklin	joule/coulomb = volt
Field, E	dyne/franklin	volt/m.
Permittivity, D/E	franklin²/erg cm.	coulomb/volt m. = sec./ohm m.
Value of permittivity of empty space	$1\ \frac{\text{franklin}^2}{\text{erg cm.}}$	$\frac{1}{9 \times 10^9}\ \frac{\text{sec.}}{\text{ohm m.}}$

THE international procedure which in normal times can be adopted for agreement or otherwise to suggested changes in the nomenclature of fundamental units cannot function at the present time, but it is hoped that Dr. Guggenheim's suggestion, which can be brought to the notice of those it concerns through the columns of NATURE, will find the favour it seems to deserve, and will prevent the 'stat-coulomb' becoming an established term, which has neither the merit of euphony nor symmetry in the systematic naming of the electrical units.

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Refractive Indexes of Gases at High Radio Frequencies

SINCE atmospheric refraction plays an important part in the bending of ultra-short radio waves round the surface of the earth, an adequate study of the propagation of these waves requires a knowledge of the refractive indexes of gases at very high frequencies. It was thought desirable to test the assumption, made in all previous theoretical work, that the values of these indexes were the same as their values at lower frequencies. When this work was begun, no figures were available for the refractive index of any gas at a frequency higher than about 4 Mc./sec. Since then, however, a result for water vapour at 42 Mc./sec. has been published by Tregigda[1].

A standing wave method has been used in this work, the standing waves being produced in a gas-tight concentric tube Lecher circuit, by bringing it into resonance with a highly stable crystal-controlled oscillator to which it was loosely coupled. The apparatus was so constructed that the changes in the length of these standing waves as the pressure or composition of the gas inside was varied could be determined with some precision, the refractive index of a gas for a wave of given frequency being equal to the ratio of the length of the wave in a vacuum to the length in the gas. The concentric tube form of Lecher system is very suitable here, as the gas under investigation can be placed in the space between

the inner and outer tubes, and further, the outer tube itself forms a most effective shield from external disturbances. The temperature of the concentric system was maintained constant by a steam jacket round the apparatus, while the temperatures of the oscillating crystal and the water vapour supply were stabilized by means of radiation thermostats, based on that developed in this Laboratory by Laby and Hopper[2].

Results have been obtained for the refractive indexes of dry air and water vapour as follows: for dry air, at 58 Mc./sec., 100°C., 76 cm. mercury;

$$\mu = 1\cdot00024_0 \pm 0\cdot000006\,;$$

and for water vapour, at 58 Mc./sec., 100°C., 76 cm. mercury,

$$\mu = 1\cdot0030_1 \pm 0\cdot00007.$$

It had been hoped to carry out work at other frequencies, temperatures and pressures, and with other gases, but this has been prevented by the War.

The important part played by the water vapour in the atmosphere in the propagation of ultra-short waves can be seen from these results. The figure for water vapour is found to agree with the value of 1·0060 for the dielectric constant of water vapour at 42 Mc./sec., 99·8°C. and 76 cm. mercury, obtained by Tregigda[1] using a heterodyne method.

The work, which was carried out under the direction of Prof. T. H. Laby, was supported by the Australian Radio Research Board.

F. J. Kerr.

Natural Philosophy Department,
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October 27.

[1] Tregigda, *Phys. Rev*, 57, 294–297 (1940).
[2] Laby and Hopper, Nature, 143, 240 (1939).

Application of the Gibbs Adsorption Equation to Solutions of Paraffin-Chain Salts

Within recent years considerable doubt has been cast upon the validity of the Gibbs adsorption isotherm as applied to aqueous solutions of the paraffin-chain salts (soaps and soap-like molecules)[1,2]. The chief objection has been the numerous well-established examples of dilute solutions showing a minimum in the surface tension – concentration curve, usually at a surface tension of 30–35 dynes, presenting the paradox of a surface tension very much lower than that of water, and yet a zero or negative surface excess of solute as calculated from the Gibbs equation when applied in the customary manner.

Because of this apparent paradox, McBain and Mills[1], in a recent review, have concluded that the Gibbs equation is only a limiting law, and that terms allowing for the effects of orientation, of submerged double layer, and of free electrical charge (if any), should be included. This argument cannot be supported, however, since the systems under discussion are electrically neutral, and the other terms, assuming as they do a particular molecular interpretation of the surface layer, cannot be used as correcting factors, since they would be already included in the thermodynamically rigorous Gibbs equation.

Long and Nutting[3] have recently put forward an explanation based upon the assumption that there is a surface *layer* of solute (giving positive adsorption at the interface) above a diffuse double layer of considerable depth, the concentrations in this double layer then determining whether the "Gibbsian *surface excess*" of solute is positive, zero or negative. (The hypothetical geometrical surface is chosen so that the surface excess of water is zero.) Unfortunately for this argument the total surface adsorption as measured by the microtome method, and which would include both surface and diffuse layers, is always positive[2]. Other techniques support this invariable positive adsorption[2].

The explanation suggested below, previously tentatively discussed by Powney and Addison[4], would seem to provide a simple explanation of the above anomalies.

It is generally accepted that with the solutions under consideration micelle formation sets in at concentrations close to (probably rather less than) that at the minimum surface tension[5]. Also it seems well established that the micelle, owing to its structure, is precluded from existing in the surface layer, the surface active species being the single ionized molecule[6]. Thus the micelles may influence bulk properties such as freezing-point and conductivity, but can have little effect on the surface tension except in so far as their presence influences the concentration of single molecules in the solution. Hence the activity term in the Gibbs equation should be that for the *molecularly dispersed* solute in bulk solution[7]. The much larger amount of solute present in micelle form acts as a 'buffer', keeping the concentration of the molecularly dispersed solute sensibly constant, as shown by application of the Law of Mass Action[6,8]. Accordingly, it is not surprising that, using the activity of the solution *as a whole*, as McBain and Mills, for example, have done[1], the Gibbs equation should break down.

That the Gibbs equation holds, even with the paraffin-chain salts, when micelles are absent, is shown by the results of McBain and Wood with lauryl sulphonic acid[2]. Thus at a concentration of 0·002 gm.mol./l. (concentration at the minimum 0·006 gm.mol./l.), their measured adsorptions were +2·7 and +3·0 (microtome and interferometer respectively), that calculated by the Gibbs theorem being + 2·4 (gm.mol./cm.^{2} × 10^{10}).

The above explanation is further strengthened by calculation of the adsorption of lauryl sulphonic acid at the minimum surface tension[9] which, assuming the adsorbed film to be monomolecular, gives a value of +5·7, in good agreement with that using the microtome[2] (+5·4) (units as above). Further details will be published shortly.

A. E. Alexander.

Colloid Science Department,
The University,
Cambridge.
Nov. 18.

[1] McBain and Mills, "Reports on Progress in Physics", 5, 30 (1939).
[2] McBain and Wood, *Proc. Roy. Soc.*, A, 174, 286 (1940).
[3] Long and Nutting, *J. Amer. Chem. Soc.*, 63, 625 (1941).
[4] Powney and Addison, *Trans. Faraday Soc.*, 33, 1252 (1937).
[5] Lawrence, Annual Reports Chem. Soc., 37, 102 (1941).
[6] Murray, *Trans. Faraday Soc.*, 31, 206 (1935); Alexander, *Trans. Faraday Soc.*, 37, 15 (1941).
[7] cf. Nickerson, *J. Phys. Chem.*, 40, 285 (1936).
[8] Bury and others, *Phil. Mag.*, 4, 841 (1927); *J. Chem. Soc.*, 679 (1929); Hartley, "Aqueous Solutions of Paraffin-Chain Salts" (Hermann, 1936).
Alexander, in the press.

Vanadium Pentoxide as a Catalyst for Sodium Chlorate in Weed Destruction

It is well known that vanadium pentoxide, used as a catalyst, greatly increases the efficiency of sodium chlorate when employed as an oxidizing agent in the production of certain dyes. Investigations have been carried out to determine whether similar use could be made of vanadium in certain methods of weed destruction, more particularly in connexion with the practice of smearing the cut surfaces of bracken fronds with chlorate solution or introducing it into the tissues of bramble plants by immersing the ends of stems from which the tips have been cut.

The experiments were carried out in September of the present year. Brambles were treated by placing the cut ends of the trailing stems in small bottles each containing 50 c.c. of the various materials in aqueous solution.

Ten bottles of each of the following were employed:

(1) Vanadium pentoxide only; 0·02 per cent solution.

(2) Sodium chlorate; 10 per cent solution.

(3) Sodium chlorate; 10 per cent solution, plus 1 part vanadium pentoxide per 500 parts sodium chlorate.

Observations were made on rate of travel up the stem, as evidenced by the destruction of the parts, and on the intensity of the effects. The findings were as follows:

(1) Vanadium pentoxide only; no effect noted.

(2) Sodium chlorate only; the usual toxic effects, a fair degree of killing with dark brown scorching of the leaves, taking ten days to reach completion.

(3) Sodium chlorate plus vanadium; severe destructive effect noted after five days, the rate of travel having been greater and exceeding the final effect of the sodium chlorate solution without vanadium. Apart from this speeding up and greater intensity of killing, a remarkable bleaching effect appeared after twenty-one days. The stems for about a foot above the points of immersion became quite white, ranging to a light yellow above. The leaves took on a light yellow tint, and in the piece of cleared woodland where the trial was carried out, these vanadium-treated plants could be distinguished at a distance without reference to the labels.

Stems from all three treatments were kept under further observation. In treatment 2, they became blacker, but extremely tough and hard, and the leaves were retained. In treatment 3, the stems became soft and brittle and the leaves all broke off from the base of the petioles.

A further trial gave similar, though not so definite, results with an addition of 1 part vanadium pentoxide to 1,000 parts of sodium chlorate.

The above observations suggest the possibility of enhancing the value of sodium chlorate as a herbicide by the employment of a catalyst. Vanadium pentoxide in the proportion used would not be ruled out on the grounds of cost. It is, however, not readily soluble in water, and further investigation is required on this point.

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Nov. 20.

Spectrochemical Analysis of Eggs

In the course of an investigation into the mineral content of foodstuffs, some analyses of hens' eggs were made. The white and yolk were treated separately. The ash was analysed by the ordinary arc spectrum method, and the liquids were also analysed directly by a spark technique similar to that described by Langstroth and Macrae[1]. Calcium, magnesium and sodium were present in relatively large quantities in all specimens. Potassium and lithium were also present in fair quantity. Traces of the following elements were also found in both yolk and white: copper, iron, manganese, strontium, silicon, phosphorus and aluminium. Barium was present in the yolk but could not be detected in the white. A very small trace of lead was indicated in one specimen of white, but its presence could not be detected in other specimens. The following elements were not present in detectable quantity in any specimen: boron ($< 0·2$), chromium ($< 1·0$), molybdenum ($< 1·0$), zinc (< 10), nickel ($< 1·0$), cobalt ($< 1·0$), cadmium ($< 0·2$) and antimony (< 20, < 200); the figures given in brackets indicate limits of detection in parts per million.

These results are in general agreement with those of Drea[2] except that he reported barium, molybdenum zinc and chromium as present in both yolk and white. He also reported rather stronger indications of aluminium and strontium. Drea used graphite electrodes, and Webb[3] has shown that spurious indications of a number of elements (including barium, molybdenum, zinc, chromium, aluminium and strontium) may be obtained with these electrodes. In order to avoid this effect, the present work was done with a silver spark technique, and this probably accounts for the fact that a smaller number of elements is reported as present. My analyses indicated that the copper and manganese content was of the order 0·001 of the magnesium content and did not exceed a few parts per million. Chemical analyses[4] indicate magnesium content of order 100 parts per million and copper content of order 0·3 parts per million. From my analyses the order of magnitude of the abundance of the other metals may be roughly estimated (in parts per million) as follows: iron ($> 1·0$), strontium (0·2), aluminium (0·2) and barium (0·2).

A number of fertilized eggs were examined at different stages of development in order to try to trace changes in the passage of mineral elements from the yolk to embryo. The changes found were, however, only of the same order as the differences between different specimens at the same stage of incubation. The only conclusion to be drawn was the purely negative one that there is no rapid and obvious preferential removal of one mineral constituent from the yolk during early stages of incubation.

This work was carried out in the Physical Laboratory, Trinity College, Dublin, under the supervision of Prof. R. W. Ditchburn, with the aid of a grant from the Medical Research Council of Eire. I wish to thank Prof. T. W. T. Dillon of University College, Dublin, for his advice, and the Albert College, Glasnevin, for a supply of eggs.

R. PRESS.

Trinity College,
Dublin. Nov. 19.

[1] Langstroth and Macrae, *Can. J. Res.*, A, **16**, 17 (1938).
[2] Drea, *J. Nutrition*, **10**, 354 (1935).
[3] Webb, *Sci. Proc. Roy. Dublin Soc.*, **21**, No. 46, 501 (1937).
[4] McCance and Widdowson, "Chemical Composition of Foods".

'Klino-kinesis' of Paramecium

THE suggestion made by Gunn and Walshe[1], that the avoiding reaction of Paramecium fits into the scheme of klino-kinesis, receives some support from the behaviour of the animal in a uniform high temperature, as I described it in 1939[2]. If the temperature of a culture is gradually raised, nothing happens at first except an increase in the speed of the animals. Then at a temperature of about 30° C. avoiding reactions begin, and as the temperature is further raised they become more frequent, with the result that forward motion practically ceases and the animals dance backwards and forwards like particles in Brownian movement. If the temperature is kept steady soon after avoiding reactions have begun, they gradually become less frequent and finally cease altogether. Once the rate of occurrence of the reactions has become very high, however, there is no acclimatization and death soon follows.

But while the term 'klino-kinesis' may be useful as a description of the behaviour of ciliates in unusual experimental conditions, there does not seem to be any justification for its use, instead of the simpler term avoiding reaction, for the ordinary behaviour. For when a paramecium retreats from a hot region or from contact with a solid object, there is no question of sensory adaptation. What happens is that a stimulus is received, a reaction follows, and in many cases this directs the animal away from the stimulating region. There need be no teleological assumption that a reaction occurs *in order to* avoid things: the implication is the quite correct one that by the reaction the animal does, in fact, avoid certain situations.

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Rusholme,
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Dec. 3.

[1] Gunn and Walshe, NATURE, 148, 564 (1941).
[2] Yapp, "Introduction to Animal Physiology" (Oxford, 1939).

Production of Proliferation-promoting Factors by the Ultra-violet Irradiation of Algæ

PREVIOUS papers from these laboratories have shown that the subjection of yeast, other micro-organisms, and several animal tissues to various forms of injury, such as ultra-violet irradiation, X-rays, mechanical injury, chemical irritation and oxygen lack, results in the release into the intercellular fluids of substances which stimulate cellular proliferation. Because of the mode of formation these substances have been spoken of as "intercellular wound hormones"[1].

In order to determine the generality of the phenomenon it has been of interest to extend the experiments to as wide a variety of cells as possible. Accordingly, preliminary experiments were carried out with mixed cultures of algæ in which the algæ were subjected to ultra-violet irradiation and the cell-free filtrates obtained from the irradiated algæ were tested for their power to increase the proliferation of fresh alga cultures. The preliminary indications having been favourable, more quantitative experiments were carried out and are reported in this note.

30–40 c.c. of a heavy suspension of *Hormidium floccidum*[2] in Detmer's 1/3 medium were irradiated with a Sperti Mercolite ultra-violet lamp (42*TC*) for from two to three hours at distances of 15–25 cm. The suspension was stirred mechanically throughout the irradiation period, as was a similar, but non-irradiated, control suspension. At the end of the irradiation period, both suspensions were filtered, first through filter paper and then through sterile Berkefeld "N" filters. 1 c.c. of the filtrate from the irradiated algæ was added to 5 c.c. of a very dilute fresh suspension of the algæ in Detmer's 1/3 medium, and 1 c.c. of the control filtrate was added to another 5 c.c. of the alga suspension. Four or five tubes were used in each run for both filtrates. Sterile technique was employed throughout. The tubes were kept for 2–3 months at a temperature of approximately 25°–30° C. in the light. At the end of the experimental period the number of algæ in the experimental and control runs were counted by means of a hemacytometer.

Eighteen determinations were made in four separate experiments. In every case the algal suspension treated with the filtrate from the irradiated algæ contained more cells than the corresponding suspension to which the filtrate from the non-irradiated suspension was added, the increase in the various experiments running from about 45 to 115 per cent. These results, in conjunction with the more extensive work in our laboratories on other organisms, indicate to us that algæ, when injured with ultra-violet radiations, release into the intercellular fluids substances which stimulate proliferation of the algæ.

These experiments are being extended to other algæ, including *Stichococcus bacillaris* and *Chlorella pyrenoidosa*. The results will be reported in detail later. The possible effect of the irradiated extracts on chlorophyll formation will also be considered.

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ELTON S. COOK.

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Nov. 5.

[1] See for example: Fardon *et al.*, NATURE, 139, 589 (1937); *Studies Institutum Divi Thomæ*, 2, 39 (1938) and 2, 233 (1939); Loofbourow *et al.*, NATURE, 142, 573 (1938); 143, 725 and 144, 553 (1939); *Studies Inst. Divi Thomæ*, 2, 137 (1938); 2, 155 (1939); *Arch. exptl. Zellforsch.*, 22, 607 (1939); *Biochem. J.*, 34, 432 (1940) and 35, 603 (1941); Cook *et al.*, Atti X° congr. intern. chim., 5, 26 (1939); *Biochem. J.*, 34, 1580 (1940).
[2] We are greatly indebted to Dr. Florence Meier Chase of the Smithsonian Institution, Washington, D.C., for the algal cultures.

Simple Modifications of the Camera Lucida for Making Larger Drawings

WHEN drawing objects under a microscope with a camera lucida the size of the drawing is normally dependent solely on the magnification of the microscope. Usually this magnification can be adjusted to give a drawing of the required size; but when drawing objects which are only a few microns long, such as chromosomes or the spores of fungi, the image produced by even the highest powers of the microscope is too small to give a drawing of a reasonable size. The devices described below are for the purpose of making large drawings with a camera lucida in such circumstances.

In using a camera lucida the image of the object seen down the microscope is made to coincide with the image of the drawing (and hand and pencil) produced by the prism and mirror of the camera lucida. Now if the image of the hand and pencil is, by optical means, made small relative to that of the object, a large drawing will result. What appears to be a very small hand with a minute pencil traces the drawing in the usual way, and appears to draw it the same size; but as the hand and pencil are in fact their usual size the drawing is an enlarged one.

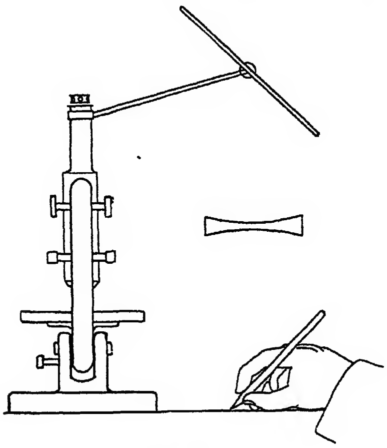

Fig. 1

This result may be achieved in one of three ways: (1) by placing a *concave* lens between the camera lucida mirror and the drawing (Fig. 1); (2) by replacing the plane mirror of the camera lucida by one which is *convex*; (3) by using three plane mirrors instead of the usual one, arranging them as shown in Fig. 2.

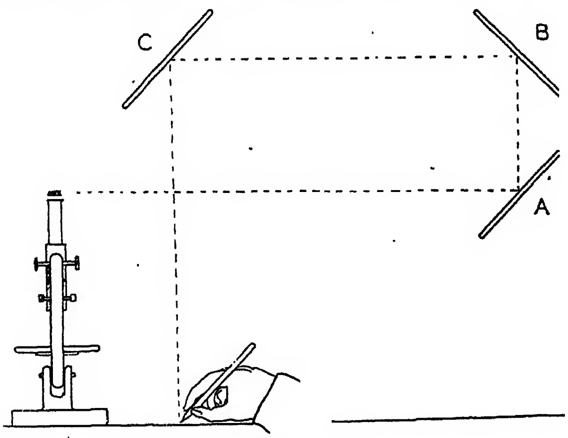

Fig. 2

The simplest of the three ways is the first, using a concave lens. This should be placed about half-way between the mirror and the drawing. If the lens is too high the image of the pencil may come within the least distance of distinct vision so that the eye will not be able to focus it sharply. If the lens is too near the paper the drawing will not be much enlarged. When looking down the microscope the image of the concave lens should come in the centre of the field. The lens should be fairly large so that the work can be confined to near its centre, as there is some distortion near the edges.

The second method, using a convex mirror in place of the plane mirror of the camera lucida, is very similar to the first. A convex driving mirror of a car is suitable for the purpose. The centre of the mirror should be at the height of the prism of the camera lucida and its general direction should be at 45° to the vertical. It may be necessary to fit the convex mirror rather farther from the microscope than the mirror it replaces, to prevent the image of the pencil from coming within the least distance of distinct vision.

In the third method three plane mirrors, *A*, *B*, and *C* are substituted for the usual one as indicated in Fig. 2; retort stands or other means of support are not illustrated. *A* may be almost any distance from the microscope; the farther away the greater the drawing. It is at the same height as the camera lucida prism and is tilted upwards at 45°. *B* is vertically above *A* and is tilted downwards at 45°. *C* is near the microscope, vertically above the drawing and at the same height as *B*; it is tilted downwards at 45°, at right angles to *B*. *C* must be high enough not to obscure the view of *B* from the prism. This arrangement is a little more troublesome to set up than either of the other two; but enables a drawing of any required enlargement to be made, and, provided good quality mirrors are used and they are at 45°, there is no distortion.

The image of the pencil is brought nearer to the eye by the first and usually by the second methods, and is taken farther away by the third method than it is with an ordinary unmodified camera lucida, and some may experience difficulty in controlling the focusing of their eyes so that the pencil is clearly seen through the camera lucida even when the lighting is properly balanced. This is because when looking down a microscope which is in focus the object appears to be sharply focused whether the eye is focused for near or for distant vision; but the pencil seen through the camera lucida is clear only when the eye is focused for the one particular distance. If the eye is focused for almost any other distance the object will be clearly seen, but the pencil will not. Those who find difficulty in focusing their eye on the pencil will find it helpful momentarily to shade the substage mirror of the microscope with the hand.

I wish to thank Miss F. L. Stephens for directing my attention to the problem and for helping me try the methods.

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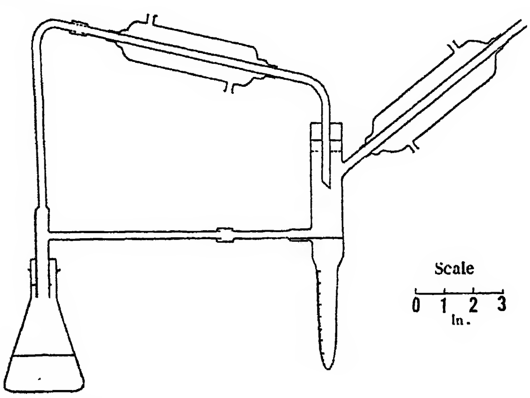
Nov. 21.

Rapid Determination of Water in Animals and Plants

IN a recent communication, Lowndes[1] has pointed out the advantages attained by applying the Dean and Stark method[2] for the determination of water to plant and animal tissues.

A modification of this well-known method has been used for the determination of water content of tumour tissue in these laboratories. The main disadvantage experienced in the use of the normal type of the Dean and Stark apparatus with solvents lighter than water lies in the fact that droplets of water adhere

to the condenser column. This adhesion of water is recognized in the method of water determination covered by British Standards Specification, 756—1939, in which the recommendation is made that it should be removed to the receiving column by a soft camel hair brush. We have eliminated this disadvantage, however, by modifying the apparatus as shown.



The condensed water is washed into the receiver by succeeding portions of liquid, whilst the return flow takes place through a lower connecting tube. The second condenser is introduced to prevent any loss of solvent. Connexions are made by synthetic rubber ('Neoprene') tubing, which is resistant to organic solvents, across butt-end glass joints. We are indebted to Mr. L. G. Wilkinson for the construction of this apparatus.

In our determinations benzene (b.p. 80°) was used rather than xylene (b.p. 135°), as it was considered that use of the former would give results more comparable with those obtained by dehydration at 105°. A determination on a 5 gm. sample takes approximately one hour.

The accuracy of the method is limited by error in reading the volume of water (for example, an error of 0·05 c.c. on a 1 c.c. reading will produce a percentage error of five), and its use is therefore restricted to bulk samples from which 5–10 c.c. of water can be obtained. Experience showed that the use of a measuring tube narrower than that illustrated was unsatisfactory, as the globules of water imprisoned benzene in the lower part of the tube.

For small samples (up to 1 gm.) the method of dehydration at a 100° has been employed.

The tissue, weighed into a combustion boat, was introduced into the inner tube of a small horizontally placed Liebig condenser. Heating is effected by passing steam through the outer jacket. A current of air dried by bubbling through sulphuric acid is passed over the sample. The moisture taken up by the air is absorbed in two tared calcium chloride tubes. Since the weight of water in the tissue is much greater than the dry tissue weight, a very accurate determination of water can be effected on small specimens.

The modified Dean and Stark method has been particularly useful as a means of obtaining average values for the water content of mouse tumours (Twort carcinomata).

Surplus moisture is first removed by laying the tissue on filter paper. In one batch of mice the moisture content of six tumours, estimated by the second method described, gave values of 80·0, 81·5, 72·4, 76·9, 77·6, 84·8; the Dean and Stark method applied to the remaining twenty-three tumours, taken four or five at a time, gave the figures 79·1, 78·9, 79·0, 78·8, 78·9, 78·8.

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Hosa Research Laboratories,
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Nov. 20.

[1] Lowndes, A. G., Nature, 148, 594 (1941).
[2] Dean and Stark, *J. Ind. Eng. Chem.*, 12, 486 (1920).

A rapid method for the estimation of water in animals and plants consisting of distillation with an immiscible liquid has been suggested[1]. The liquid used was xylol, and some charring of sugar occurred. If toluene (b.p. 110·7° C.) is substituted for xylol, the amount of decomposition and charring is much reduced and is scarcely appreciable even with sugar-containing substances such as jam, honey, fruit extracts, and confectionery products. The boiling-point of toluene is sufficiently high to ensure rapid and complete vaporization of all water present, and the method gives results comparable with those obtained by drying *in vacuo* or by oven drying after the addition of alcohol, and higher than those obtained by 'straight' oven drying, at 105–110° C.

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Nov. 24.

[1] Lowndes, A. G., Nature, 148, 594 (1941).

Employment of Physicists

In view of the statements made in recent articles in Nature regarding the employment of scientific workers in connexion with the national effort, the following statement of the situation as it concerns members of the Institute of Physics may be of interest.

With negligibly few exceptions all our members are at present engaged in a professional capacity, practically all of them on work either directly or indirectly connected with the war effort. Owing to the pressure for greater output from all works and factories, a certain number of our less senior members with substantial research experience are now engaged on more or less routine work (testing, servicing, and so on) which does not exercise their abilities to the full. It must be remembered, however, that the work they are doing is essential to the maintenance of quality and output, and that both would suffer if the men were taken for higher duties before suitable juniors had been trained to replace them. It may be pointed out, in this connexion, that the present intensive drive for the production of radio experts will inevitably mean that fewer fuller trained physicists will be turned out by the universities.

Only the Cabinet and its advisers can be in a position to know the relative importance at the moment of research, industrial production and operational control (either with or outside the armed forces). So far as physics is concerned, the available man-power is already fully engaged, but it would certainly be possible to increase the research potential, if that is desired, at the expense of other forms of war service.

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MODE OF ACTION OF CHEMOTHERAPEUTIC AGENTS

THE Biochemical Society held a discussion meeting on the mode of action of chemotherapeutic agents on November 29 at the Courtauld Institute of Biochemistry, Middlesex Hospital, Prof. E. C. Dodds being in the chair.

Dr. G. M. Findlay, in opening the discussion, said that chemotherapeutic action can be classified as direct or indirect. Except in the case of parasites present in the intestinal canal, it is essential that the chemotherapeutic drug should be absorbed into the body, that it should penetrate to the site where the parasites are acting, and that it should not be excreted or converted too rapidly into an inert form. Time must be allowed for chemotherapeutic action, and in some cases for the conversion of the compound from an inactive into an active form.

When once the drug and the parasite have been brought face to face, three stages can be distinguished, adsorption, interference with metabolism, and death or such injury to the parasite that it is destroyed by the phagocytes of the host. An absorbed chemotherapeutic drug may prevent an essential food factor from being adsorbed or it may cause a breakdown in metabolism by combining with a specific substrate or by competing with an essential cell metabolite for an enzyme or coenzyme. One break in the chain of metabolic reactions may rapidly give rise to others. Specific immune serum and sulphapyridine do not compete for the same receptor group in the pneumococcus and may therefore enhance one another.

Parasites may be killed in the body without the aid of phagocytes, but usually when a parasite has been damaged it is destroyed by the normal defence mechanism of the host.

Indirect action produces such changes in the environment that parasites can no longer grow. Physical changes may prevent growth, the temperature or the *p*H reaction may be altered, the formation of immune bodies may be stimulated or the character of the cells may be altered, as in the treatment of gonococcal vulvovaginitis in children with œstrin preparations. The highly specific action of certain drugs and the no less specific reactions of certain closely allied parasites can be explained by postulating that, after adsorption of the compound at the parasite/solution interface, the nature of the interference with the metabolism of the parasite depends on what groupings in the molecule of the compound come within the influence of other acceptor groups in the parasite: there is thus a multipoint action.

Prof. A. Fleming, continuing the discussion, said that in 1929 he applied the name penicillin to an anti-bacterial substance of unknown constitution elaborated by *Penicillium notatum* when grown in ordinary bacteriological media or in a modified Czapek-Dox medium. The action is mainly bacteriostatic and shows a marked degree of specificity. Pyogenic cocci, Clostridia and some other bacteria are sensitive, while the coli-typhoid, hæmophilic chromogenic bacilli and others are insensitive. Pathogenic Gram-negative cocci (Gonococcus, Meningococcus and *M. catarrhalis*) are sensitive, while saprophytic varieties, for example *M. flavus*, are insensitive, thus differing from the sulphonamides.

The action of penicillin is not interfered with by substances that inhibit sulphonamides, bacteria, bacterial extracts, pus fluids, tissue autolysates, peptones and *p*-aminobenzoic acid. Penicillin is non-toxic to leucocytes and animals, but in low dilutions it affects the morphology of bacteria and interferes with division. As penicillin and also gramicidin are apparently of a different constitution from the sulphonamides, the isolation and synthesis of the pure active principles will open up a new chemotherapeutic field.

Prof. Warrington Yorke described the action of the aromatic diamidines which were evolved by Dr. Ewins, after it had been shown that synthalin (decane diguanidine) acts on trypanosomes not by reducing the sugar but by direct toxic action. Some aromatic diamidines exhibit a remarkable trypanocidal activity. The most active are 4 : 4′-diamidino-stilbene, 4 : 4′-diamidino-diphenoxy-propane and 4 : 4′-diamidino-diphenoxy-pentane. Cases of kala-azar have now been successfully treated by diamidine-stilbene—Indians, children in the Mediterranean area and patients with the Sudanese variety, which is resistant to antimony. Babesia infections in dogs have been cured by the stilbene and propane derivatives, the stilbene being highly active against *Trypanosoma congolense*. The compounds have a highly specific action. Drug resistance appears to be due to a change in the surface layer of the parasite. Trypanosomes resistant to a number of compounds have now been prepared, including a diamidine preparation. It has also been possible to prepare a diamidine-resistant Babesia and a plasmoquine-resistant strain of *Plasmodium knowlesi* in the monkey.

Discussing trypanocidal substances, Dr. F. Hawking said that from the phenomenon of drug resistance four kinds of receptors on the trypanosome are recognized. Trypanocidal action comprises fixation of the drug, secondary chemical reactions inside the cell and death. Only about the first process is much known: it occurs quickly in a few minutes and is reversible. With arsenical compounds, fixation apparently depends on the tervalent arsenic atom linked to a benzene ring. Certain side chains ($-NH_2$, $-OH$) prevent fixation on animal cells but not on normal trypanosomes: the receptors of resistant trypanosomes are modified. Over a wide range, the amount of drug fixed is proportional to the concentration in the surrounding fluid: in the case of acriflavine the partition ratio (concentration inside the trypanosome/concentration outside) is 8,000 for normal trypanosomes, 60 for resistant trypanosomes. Fluorescent compounds, acriflavine and diamidino stilbene, are concentrated in the blepharoplast and cytoplasmic granules of the trypanosome.

The importance of having a theory of chemotherapeutic action was emphasized by Sir Henry Dale, who congratulated the Society on arranging a discussion meeting in war-time. It was one of Paul Ehrlich's great contributions to the subject to have produced theories which, though they will probably not survive unmodified, have given tremendous stimulus to research; thus, his explanation of the action of certain dyes on infection by trypanosomes as due to injury of the reproductive power of the trypanosomes, without affecting their other vital functions.

At the time, this suggestion seemed artificial and unconvincing, but when Dobell and Laidlaw found a method for growing *Entamœba histolytica* in permanent culture *in vitro*, it could be demonstrated that the action of emetine was just of this type. The 'factor of persistence' is also of importance in chemotherapeutic activity. This seems to be the reason why a quinquevalent arsenical on one hand, or an arseno-compound on the other, is a better chemotherapeutic agent than the arsenoxide produced by reduction from one or by oxidation from the other, although the arsenoxide is recognized as the directly parasiticidal agent. In the same way, sulphaguanidine seems to owe its effectiveness in bacterial dysentery to its poor solubility, enabling it to remain in solid form in the intestinal contents and to keep up a steady, low concentration in contact with the infected mucous membrane. Aromatic diamidines, the brilliant promise of which has been made clear by the results reported by Prof. Warrington Yorke, may similarly owe part of their superiority to their limited solubility. Sir Henry suggested, as problems the solution of which might greatly accelerate advance in parts of the field of chemotherapy, the discovery of a method of keeping trypanosomes alive and reproductive indefinitely in artificial culture, and the discovery of a method of treating a strain of trypanosomes which has acquired a drug resistance, so as to restore the normal susceptibility.

Dr. D. D. Woods spoke of the interference of antibacterial agents and essential metabolites. This interference may be due to the formation of a compound between the antibacterial agent and the essential metabolite, as between mercury salts and —SH compounds, or by inhibition of an enzyme reaction involved in the synthesis or utilization of an essential metabolite. An example of this is the competitive inhibition by sulphanilamide of an enzyme reaction involved in the further utilization of *p*-aminobenzoic acid, this inhibition occurring by virtue of the chemical relationship of sulphanilamide and *p*-aminobenzoic acid. The latter has been isolated from natural sources and is a growth factor for *Clostridium acetobutylicum* and higher organisms. Following out this hypothesis, the following substances all chemically related to a known essential metabolite, the latter shown in brackets, have been found to have some antibacterial activity; pyridine-3-sulphonic acid and amide (nicotinic acid and amide); aminosulphonic acids (analogous amino-carboxylic acid); sulphonic acid analogue of pantothenic acid (pantothenic acid); indole-3-acrylic acid (tryptophan); barbituric acid (uracil).

Dr. H. McIlwain said that an organism which is deprived of the use of enzymes or metabolites by various types of interference is nutritionally more exacting than in its normal state. *Bacterium coli* and *Streptococcus hæmolyticus*, inhibited by acriflavine components, require for further growth two types of material not normally required. Type 1 is best replaced by nucleotides, type 2 by a concentrate of amino acids but partly by phenylalanine. In the presence of type 2 compounds, but not without, artificial hydrogen carriers are further active against inhibition of *Bact. coli*. Type 1 compounds form complex salts with acriflavine components. The inhibitors probably inactivate enzyme systems of which type 1 compounds are essential parts, of which type 2 compounds are substrates or products and of which some can be replaced by the hydrogen carriers.

The relationship between chemical constitution and bactericidal action in certain amino-acridines was described by Dr. W. H. Linnell. Among the isomeric diaminoacridines, a 1-amino group causes complete loss of bactericidal activity and reduces toxicity; a 2-amino group increases activity and this is further enhanced by another amino group in the 2-, 3-, 4-, (in the other ring) or 5-positions, accompanied by increased toxicity in the case of a second 2-substituent. When two 3-amino groups (= 3 : 7) are present, activity is moderate but the 3 : 8 diamino acridine (= 2 : 7) is as active as proflavine but less toxic. A 4-amino substitutent confers small activity, while position 5 is highly active, but probably leads to increased toxicity. Albert has shown that similar differences in activity exist among the five isomeric-amino acridines, their activity paralleling their strength as bases and their partition coefficients between oil and water. The corresponding acridones are inactive, as are certain amino derivatives of 5 : 10-dihydroacridine and of iminodihydroacridine, suggesting that the intact acridine molecule is necessary.

L. G. Goodwin said that the uncertain action of antimony in protozoal diseases, of which the resistance of Sudanese kala-azar to antimony is an example, is an added difficulty in investigating its mode of action. The active form of antimony may be the stibinoxide grouping, but while this is probable in trypanosome and schistosome infections, it is unlikely in leishmaniasis, where quinquevalent compounds are the most effective and massive dose therapy is successful.

Excretion of antimony after doses of the quinquevalent compounds or of stibophen is much more rapid than with tartar emetic. There is indirect evidence that the rapidly excreted fraction of the drug passes through the body unchanged.

Both direct toxicity action on parasites and stimulation of the hosts' defence mechanisms are produced by antimonials. Increased phagocytosis may be of primary importance in leishmaniasis, though histological work on the spleens of infected hamsters injected with a quinquevalent antimony compound suggest some degree of direct action.

Dr. E. Chain described the chemical and physical properties of penicillin in relation to its bacteriostatic action. It is a strong acid with two, or a multiple of two, acid groups. A purified barium salt gives a carbon content of 55 per cent and a hydrogen content of 6·3 per cent: only carbon, hydrogen and oxygen are present in the molecule. Methoxyl groups cannot be detected but two hydroxyl groups are present. The dried barium salt of penicillin keeps indefinitely and in watery solution is most stable between *p*H 5 and 7. With heavy metals, except $Fe^{\cdots}$, it forms water-soluble salts. The antibacterial action is lost by oxidation with hydrogen peroxide and potassium permanganate. Dr. E. P. Abraham said that the instability of penicillin necessitates three methods of purification dependent on distribution between solvents, adsorption and reduction. The crude barium salt obtained from an amyl acetate extract of the medium has an activity of 15–25 units per mgm. Distribution between water and ether at *p*H 2 and *p*H 6, adsorption of impurities by charcoal and chromatographic analysis on alumina yield a light yellow barium salt with an activity of about 150 units per mgm. On reduction of this material in neutral solution with aluminium-mercury couple the remaining pigment is adsorbed by alumina. The

white barium salt obtained from the supernatant has an activity of 240 units per mgm. It completely inhibits Staphylococcus in a dilution of 1 in 5,000,000, partially in a dilution of 1 in 16,000,000.

The behaviour of sulphanilamide, p-aminobenzoic acid and chemically related compounds, aniline and sodium benzenesulphonate, at the surface of *Bact. coli* has been studied by Dr. F. R. Bradbury and D. O. Jordan by electrokinetic methods. The shapes of the curves relating variation of mobility with time of contact for sulphanilamide and p-aminobenzoic acid are quite different from those of the curves for aniline and sodium benzenesulphonate. The curves for sulphanilamide and p-aminobenzoic acid are similar, suggesting that the two compounds behave in a like manner at the bacterial surface.

Prof. A. St. G. Huggett said that dyes such as chlorazol sky blue *F P S* (Chicago blue) and chlorazol fast pink *B K S* are excellent anticoagulants. Structurally, they resemble afridol violet, from which Bayer 205 is derived; they have a trypanocidal action while Bayer 205 has an anticoagulant action. The dyes act at two points in the clotting mechanism as antikinase and antithrombin. Their anti-enzyme action with blood clotting may have an analogy to their mechanism as trypanocidal agents.

CO-ORDINATION OF SCIENTIFIC AND TECHNICAL WORK

AT a conference organized by the Association of Scientific Workers and held at Birmingham on December 6, the need for greater co-ordination and collaboration in all fields of applied science was urged. The essential part which the scientific worker has to play in the modern community was emphasized by Mr. D. P. Riley, who opened a discussion on "The Responsibilities of the Scientist to the Community". Not only most of the greatest industries but even agriculture are dependent upon his work if they are to develop rapidly enough to satisfy the needs of the whole community, and in time of war it is even more important that this should be recognized, particularly in view of the five years' start which our enemies have over us in the application of science to war problems. As an interesting example of the need for the proper understanding of the scientific facts underlying certain decisions by those entrusted with executive power, Mr. Riley took the case of the encouragement of the consumption of wholemeal bread on account of its vitamin B content. The fact that this bread also contains an appreciable amount of phytic acid, the calcium salt of which is insoluble, and the consequent danger of avoiding vitamin B deficiency only at the expense of incurring calcium deficiency, has apparently not yet been given attention in public policy. Not only are many scientific workers still not occupied to their full capacity, but they are even in some cases urged to give their attention to the development of post-war plans, as well illustrated by an advertisement in a well-known daily paper describing a sewing-machine made largely of plastics and saying that now is the time to plan its post-war production.

The Association of Scientific Workers, which is working to secure the fullest application of science in the service of the community and a responsible status for men of science, is trying to meet the need for organization without which the individual man of science can do little in his attempt to ensure that his work is used for the war effort. In particular, the Association wishes for any evidence of definite misapplication or inefficiency in the use of scientific man-power, since it has been requested by the Ministry of Supply to prepare a report on this subject.

The immediate problems of producing and maintaining equipment for our armed forces was dealt with by Mr. Swann in his address on "The Role of the Scientist in the National Effort". He produced figures to demonstrate the superiority of Germany and the occupied countries over ourselves and the U.S.S.R., including also the help given by the United States, leaving no ground for optimism. He mentioned the dissipation of effort in competition between private firms, the operation of the 'cost-plus' contract, inadequate pooling of information and the determined grip of firms on their trade secrets as some of the many factors combining to hold up production, and criticized the feeling of complacency fostered by Russia's successes and America's promises of support. He urged the formation of production committees, where these do not already exist, on which technical staff should play an active part, and the need to provide the Ministry of Supply with all relevant facts as to means to eradicate inefficiencies.

Mr. J. A. Henley pointed out how, as the industrial scientist has passed from the position of being an independent consultant or even his own manager to that of one wage-earner among many in a large firm, it has become necessary for him to co-operate with his fellows in a professional organization which could look after his interests and his status. This need has become peculiarly great since the outbreak of war; hence it is not surprising that the Association of Scientific Workers has grown very much faster since its registration as a trade union than formerly.

After discussion, the following resolutions were passed:

"The Birmingham Conference of Scientific and Technical Workers reciprocates the expressed desire of the scientists of the U.S.S.R. for the fullest possible co-operation in the fight against Fascism, and pledges its maximum efforts to this end.

"This Conference, realising that maximum efficiency in the war effort will be achieved only as a result of fullest possible co-operation between technical staffs, work-people, and those in control of production, supports all activities leading to this end, in particular the setting up of production committees.

"This Conference calls for complete pooling of technical information between manufacturing companies with similar problems.

"This Conference stresses that the present anomalies in conditions of working and remuneration must lead to grievances that seriously hamper the war effort."

SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

THE Annual Conference of the Society of Agricultural Bacteriologists, held at the Midland Agricultural College during September 12–13, covered a wide range of subjects. The papers may be classified, somewhat arbitrarily, into those concerned with dairying and those with other fields.

Instances of the economic importance of the sulphate-reducing bacteria included the formation of the black colour in the mud of certain districts, the evolution of hydrogen sulphide in sewage, and the discoloration of paper pulp. The role of these bacteria in the underground microbiological corrosion of metals was considered in some detail. Another paper described how the principle of the activated sludge process may be applied to an aerated culture of nitrogen-fixing bacteria so as to build up continuously a stock of bacterial protein from carbohydrate and atmospheric nitrogen.

Media containing thallium salts have been found to yield excellent results in the diagnosis of streptococcal mastitis and in the isolation of lactic streptococci from milk and fæcal streptococci from water samples.

Papers of considerable interest to water bacteriologists dealt with investigations on the bacterial flora of lakes and streams. In lakes during the winter months, when the waters are in circulation, the counts of bacteria tend to be much the same at different depths, while during the summer, when the waters are stratified in two layers, counts in the upper layer are of a higher order than those in the lower layer, where they tend towards a low constant value. Coliform bacteria in relatively pure lakes and streams, though smaller in numbers than those in waters subject to pollution, show unexpectedly a higher proportion of the fæcal type.

Items of general interest included recommendations for economy in the war-time use of peptone for bacteriological media, and the role of statistics in the planning of experiments and in computing the error of the plate count.

In the field of dairy bacteriology, there were several papers on the methylene blue and the resazurin tests for bacterial quality of milk. A high correlation has been observed between the plate count and the methylene blue test and between the reduction of methylene blue and the reduction of resazurin to the vivid pink stage. Two causes of anomalous results in these tests are: (*a*) the growth of cryophilic bacteria during storage of milk samples in the refrigerator; and (*b*) the decrease, during storage, in the reducing power of milk containing large numbers of leucocytes. For pasteurized milk a reduction time of six hours or less in the test at 15·5° C. has been found to indicate either contamination by coliform bacteria or poor keeping quality.

The phosphatase test, applied to milk pasteurized in bottles, has revealed the fact that in one of three commercial plants examined a high proportion of samples had probably been underheated. The acid-producing bacteria which predominated in the freshly pasteurized milk were rapidly supplanted by alkali-forming types and played little or no part in spoilage during storage. Heat-resistant cocci which survived pasteurization appeared to consist largely of *Micrococcus luteus* and were not derived from the cow's udder.

Several papers were concerned with the bacteriology of starters and cheese. Infection of starters with bacteriophage is found to be an important cause of general slowness in cheese-making in Great Britain, even though mixed starter cultures are customary, but the incidence of the trouble may be reduced by observing certain precautions and by adopting a 'vitality' test as a measure of control.

Studies in cheese ripening have disclosed the fact that lacto bacilli may assist flavour through the liberation of an intracellular lipase on autolysis of the cells, while some light has been thrown on the sources of the carbon dioxide evolved from cheese during storage in cargo. In Cheddar cheese the gas results from bacterial action, but in Stilton it is mainly correlated with the growth of the mould.

Problems in disinfection received attention from several workers. For hypochlorites to be effective in the treatment of dairy utensils, the latter must be scrupulously clean, free from corrosion and open seams, and must be agitated or scrubbed during treatment. A technique was outlined for routine disinfection in the cowshed to combat, *inter alia*, the spread of mastitis streptococci.

An item of interest to the dairy industry was the demonstration of a portable apparatus, depending in principle on measurement of *p*H value, for rapidly testing the quality of the incoming milk at a creamery.

THE FORTIFICATION OF FOODS

THE diet of man now contains a variety of foods very different from those consumed by his prehistoric ancestors. Cooking, which may wash out or destroy mineral constituents and vitamins, has long been practised, while more modern processes such as the decortication of cereals, and the extraction and refining of oils and fats, may lead, according to the results of animal experiments and clinical evidence of human disease, to dietary deficiencies. Recent advances in methods of analysis of foods and in our knowledge of man's need for some of the vitamins and essential minerals have enabled us to estimate the dietary significance of these more modern methods of preparing foods. Now that a number of synthetic vitamins or vitamin concentrates are available it is possible in some cases to fortify foodstuffs so as to increase man's intake of these essential dietary factors to the level which modern investigations have shown to be desirable.

The great interest attached to this problem of fortification was reflected by the very large attendance at a joint meeting of the Society of Public Analysts

and Other Analytical Chemists, and the Food Group of the Society of Chemical Industry held at Burlington House on December 3 to discuss "The Fortification of Human Foods by the Addition of Specific Nutrients".

The first paper on "The Principles of Food Fortification" was read by A. L. Bacharach, who defined fortification, which he held to be synonymous with enrichment, as the addition of specific nutrients. He laid down a number of principles which should govern the whole policy of fortification. The amount of enrichment should be adjusted to the need of the consumer for the specific nutrient; this might have to be altered at different times or in different areas according to the amount already available in the diet. The nutrient should be added to some widely consumed foodstuff, such as bread or margarine, in order to ensure even distribution to the whole community, and, as the need must be greatest for those of limited means, fortification should not result in an increase in the cost of the foodstuff, which might defeat the principle of general distribution. Precautions should be taken to ensure that the consumer actually received the added nutrient, which should be stable and not be physiologically incompatible with any other component of the fortified food. Due allowance should be made for any loss likely to occur during the normal preparation of the foodstuff for the table. Fortification should not impair taste or flavour and so should not be detectable by the consumer, though the analyst should be able to determine the amount of the nutrient present. Mr. Bacharach's last principle, that of disclosure, is one which has not yet received official recognition in Great Britain, though it was endorsed by all subsequent speakers. When a food is fortified with a particular nutrient the amount of this nutrient present should be stated in simple and concise chemical or biological units and not, for example, in terms of 'summer butter'.

Illustrating his principles by references to examples of fortification already in operation in Great Britain or in the United States, Mr. Bacharach pointed out that the addition of iodine to table salt was probably the first fortification which was carried out not simply to replace something lost during purification but to overcome what is, in some areas, a known dietary deficiency in iodine by distributing this element in a simple and economical manner. Thus the aim of fortification should be to remedy some known dietary deficiency, not merely to imitate some allied foodstuff; white bread fortified with calcium is a better source of available calcium than wholemeal, though it may be inferior to wholemeal in other respects; vitaminized margarine should, if the need arises, contain more of the vitamins A and D than summer butter.

Mr. Bacharach vigorously attacked the naturalist school which professes an almost mystical belief in the superiority of dietary factors present in, or isolated from, natural sources. Members of this school would, apparently, condemn the fortification of flour with synthetic aneurin, but would applaud the same fortification if made with vitamin B_1 laboriously isolated from yeast. Ascorbic acid cannot wholly replace orange juice, but it can prevent scurvy if administered in the proper amounts.

Mr. Bacharach concluded by referring to the need for extending fortification to cover other nutrients and mentioned the advances which have been made in the United States. Iron should be added to white bread, and attempts should be made to lower the cost of production of riboflavin.

The second paper, on "The Technological Aspects of Fortification" by Drs. D. W. Kent-Jones and A. J. Amos, was read by Dr. Amos, who distinguished between fortification and enrichment, preferring to reserve the former term for cases in which losses of nutrient due to purification are made good, as, for example, when B_1 is added to white flour, or when a food is strengthened with some particular nutrient to make it equivalent to some allied food, as when vitamins A and D are added to margarine. Enrichment, on the other hand, should be reserved for additions of a nutrient to a food which is not normally a good source of the nutrient.

The methods adopted to carry out fortification must ensure uniform distribution without loss of the added nutrient, which should have no effect on the palatability or keeping quality of the final product. The fortification of margarine with vitamins A and D was carried out by some manufacturers long before compulsory fortification was introduced in Great Britain. In the early days concentrates were used which sometimes imparted flavour, but with the introduction of calciferol and whale oil concentrates this difficulty was overcome.

The fortification of white bread with B_1 has been achieved in three different ways, all of which are now being used in Great Britain and in the United States. In the method adopted by the Ministry of Food, aneurin is added to the flour during the milling process. The physical properties of aneurin render impossible the direct addition of the small amount required (0·2 gm. aneurin to 280 lb. flour), so a concentrate similar to flour is prepared by spray drying a suspension of flour in water containing the requisite amount of aneurin. The addition of 1 oz. of this concentrate to each 280 lb. flour is then performed without difficulty by a special mixer. In the second method of enrichment the B_1 is introduced into bread via the yeast used to ferment the dough. This yeast, obtained by cultivation in a special medium, contains about sixty times as much B_1 as ordinary yeast. The third method is based on the addition of 20–25 per cent wheat germ to flour.

The proposed enrichment of flour with calcium is not yet in operation, partly because opinion is divided as to the merits of the scheme, but also because of technical difficulties. Creta Præparata has been chosen as the most suitable form of calcium carbonate, since it has the least effect on the hydrogen ion concentration of the dough.

The lack of stability of ascorbic acid in aqueous solution causes practical difficulties in fortification. The addition of this vitamin should be made as late as possible during the process, aeration should be avoided and care taken to exclude traces of copper and iron. If vitamin C is added to a fatty food, a water in oil suspension should be used. The difficulties encountered with vitamin C serve to emphasize the need for careful control at all stages of the fortification process. As an example of what can be done even with an unstable substance, Dr. Amos mentioned that jam for dispatch to British prisoners of war is fortified with vitamin C. The loss during manufacture is not greater than 15 per cent, while the loss on storage for twelve months in sealed containers does not exceed 20 per cent.

H. E. Cox later gave a paper on "The Machinery for the Enforcement of Standards for Fortified

Foods". Dr. Cox assumed that, in normal times, fortification will be optional and not compulsory. If optional fortification becomes general, the law will need fortification to deal with the chaotic conditions which would probably result from wild claims made for various fortified foods. At present the Ministry of Food has control of fortification, but, in times of peace this control should pass to the Ministry of Health, when fresh legislation will be necessary to empower the Minister to issue regulations covering fortification. Indeed, Dr. Cox argued that the present activities of the Ministry of Food are directly contrary to the will of Parliament as expressed in the Foods and Drugs Act 1938.

According to this Act the Ministry of Health may restrict or prohibit additions to food, but has no power to order that additions be made. When the emergency control of the Ministry of Food is ended, the new regulations should prescribe maximum and minimum limits for fortification as is now being done in the United States. These limits must be capable of detection by analysis, hence the urgent need for the standardization of methods of analysis. Eventually this analytical control should be done by the public analyst and not by nominees of the Ministry of Food. If the public analyst is to guard the public against fraudulent claims, all fortified foods must be clearly marked with the actual amount of added nutrient present in the food, and no vague claims that vitamins have been added should be allowed.

The final paper, on "Analysis of Fortified Foods", was given by H. E. Monk. As methods of analysis for minerals are well known, Mr. Monk confined his remarks to a well-balanced summary of the methods of analysis for vitamins and of the difficulties likely to be encountered by the public analyst employing these methods. Since fortification with vitamins is to be carried out for nutritional purposes, it might appear at first sight that biological assay should be used when possible. Chemical and physical methods have the advantages of speed, accuracy and cheapness and, except possibly for vitamin D, are likely to replace the lengthy biological assays. Microbiological assay such as is used for riboflavin should not, however, be excluded.

To carry out a physical or chemical estimation it is first necessary to extract the vitamin from the foodstuff, and great care is needed to ensure that this extraction is complete. Having obtained the vitamin extract, precautions must be taken against loss during the estimation. Finally, the method used should be specific for the vitamin, and in cases of doubt, alternative methods should be used wherever possible in order to guard against erroneous results due to the presence of interfering substances.

In the spirited discussion which followed, repeated reference was made to the necessity for disclosing the vitamin content of fortified foods. Thus it was stated that the vitamin D content of margarine has recently been doubled in order to make up for the lack of eggs. Only three members present admitted that they were aware of this change.

It was generally agreed that the meeting had been one of the most successful of its kind and that the knowledge of the tasks which lay ahead should inspire the chemist to investigate the accuracy of present methods and devise new methods for the rapid estimation of vitamins.

E. R. D.

FORTHCOMING EVENTS

SATURDAY, DECEMBER 20

BRITISH PSYCHOLOGICAL SOCIETY (at Tavistock House, Tavistock Square, London, W.C.1), at 11 a.m.—Discussion on "Problems Affecting the Under-Fives in Total War".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (December 29).

EDUCATIONAL PSYCHOLOGIST and a PSYCHIATRIST—The Secretary for Education, Education Offices, York (December 30).

TEACHER OF ENGINEERING DRAWING in the Department of Mathematics and Physics of the Polytechnic, Regent Street, London, W.1, now at Lancaster—Dr. J. Topping, Storey Institute Technical College, Lancaster.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 47, Section A, No. 1: On the Solutions of Wave Equations for Non-Vanishing Rest-Mass including a Source-Function. By Erwin Schrödinger. Pp. 24. 1*s*. Vol. 47, Section A, No. 2: Experiments on Condensation Nuclei. By P. J. Nolan. Pp. 25–38. 1*s*. Vol. 47, Section B, No. 1: Descriptions of Five New Species of Alyshdae (Hymenoptera) and Notes on some Others. By A. W. Stelfox. Pp. 16. 1*s*. Vol. 47, Section B, No. 2: The Cytoplasmic Bodies of Drosera. By J. Brontë Gatenby and J. D. Smyth. Pp. 17–20. Vol. 47, Section B, No. 3: The Nuclear Apparatus as shown by Feulgen's "Nuclealfärbung" Reaction. By Mildred M. Moore. Pp. 21–52. 2*s*. Vol. 47, Section B, No. 4: A List of the Microlepidoptera of Ireland. By Bryan P. Beirne. Pp. 53–148. 4*s*. Vol. 47, Section B, No. 5: The Neck Body in Normal and X-radiated Insect Spermatogenesis. By J. Brontë Gatenby. Pp. 149–160. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [2411

Other Countries

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 14): Supervision of Health and Physical Education as a Function of State Departments of Education. By Dr. James Frederick Rogers. (Studies of State Departments of Education.) Pp. vi+106. (Washington, D.C.: Government Printing Office.) 15 cents. [1311

Cornell University Agricultural Experiment Station. Bulletin 748: Fertilizers and Field Crops. 1: Results of Sixteen Years of Experiments on Volusia Silt Loam in Allegany County, New York. By E. L. Worthen. Pp. 28. Bulletin 749: Fertilizers and Field Crops. 2: Results of Sixteen Years of Experiments on Honeoye Silty Clay Loam in Monroe County, New York. By E. L. Worthen. Pp. 26. Bulletin 750: Fertilizers and Field Crops. 3: Results of Twenty Years of Experiments on Volusia Silt Loam in Cortland County, New York. By E. L. Worthen. Pp. 16. Bulletin 751: Costs of Farm Power and Equipment. By J. P. Hertel and Paul Williamson. Pp. 38. Bulletin 752: Studies on the Control of Internal Breakdown of Table Beets by the use of Boron. By G. J. Raleigh, O. A. Lorenz and C. B. Sayre. Pp. 16. Bulletin 754: A Comparative Study of High-Temperature, Short-Time, and Holder Pasteurization. By A. Millenky and H. J. Brueckner. Pp. 26. Bulletin 756: Costs and Returns from Farm Enterprises. By Paul S. Williamson. Pp. 41. Bulletin 762: Controlled-Atmosphere Storage of Apples. By R. M. Smock and A. Van Doren. Pp. 45. Bulletin 766: Controlling the Pre-Harvest Drop of Apples. By M. B. Hoffman. Pp. 18. Memoir 234: Studies on Bitter Pit of Apple. By R. M. Smock. Pp. 45. Memoir 235: A Study of Dormancy in Seeds of Polygonum. By Oren L. Justice. Pp. 43. Memoir 237: Reproduction of the Field Mouse *Microtus pennsylvanicus* (Ord). By W. J. Hamilton, Jr. Pp. 23. (Ithaca, N.Y.: Cornell University.) [1311

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NATURE

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Dec. 27, 1941

THE INTERNATIONAL LABOUR ORGANISATION

THE International Labour Organisation remains almost alone of the institutions framed to promote international co-operation, understanding and world order after the War of 1914–18. Although its staff has been drastically reduced and all but a small group of officials have been transferred to Montreal, the Organisation continues to function effectively. From its new working centre it is issuing the *International Labour Review*, its studies and reports, its Legislative Series and from time to time organizes a series of meetings and conferences. The recent Labour Conference in New York was the most outstanding of these meetings, and to many it was a surprising but impressive witness both of the contribution which the Organisation is rendering to the practical improvement of labour conditions throughout the world and of its importance in the tasks of reconstruction which already lie near to our hand.

It is not too much to say that the act of faith involved in summoning the Conference at the present period has given to the world a fresh inspiration of the worth of the principles embodied in the Organisation. Already the pledge of the delegations of Poland, Czechoslovakia, Jugoslavia and Greece, announcing the formation of a *bloc* of those nations to serve as a basis after the War for a confederation from the Baltic to the Ægean, in which the four freedoms will be assured, demonstrates how the Organisation serves, as no other institution, as a rallying point for the Governments of the nations overrun by destruction. The Organisation represents and upholds an international way of life which would build up wealth, progress and security through the pursuit of common aims and purposes, and the exploitation, not of men, but of the abundant material resources of the world.

The realization that the International Labour Organisation stands for ideals and a way of life diametrically opposed to those of the Axis powers gave vitality to the recent Conference and related it immediately to the war effort at present engrossing the attention and resources of the surviving democracies. That realization is reflected in the outstanding address of President Roosevelt to the delegates at Washington on November 7, and in such utterances as those of Mr. E. J. Humbro, president of the Norwegian Parliament, who declared : "If we do not win the war there will exist only one law in national and international labour relations—the law of master and slave."

The ringing challenge to Nazi-imposed serfdom with which the Conference resounds would alone have made it memorable in these days. Its attempt to interpret the ideals of social security and to translate into practice the four freedoms

of which President Roosevelt has spoken made it beyond question a world event the significance of which is likely to grow rather than diminish with the passage of time. The fresh impetus to the task of planning the organization of international co-operation, to ensure that the abundant productive capacities of the world are used to satisfy the needs of its peoples, may well prove its most enduring value.

What gives reality to this issue at the present time is not merely that social policy is a central preoccupation, both because of its immediate relevance to defence and because it is ultimately at the core of the issues which the War will decide. If freedom from want means economic understandings which will secure to every nation a healthy peace-time life for its inhabitants everywhere, or in the words of the Atlantic Charter, "fullest collaboration between all nations in the economic field, with the object of securing for all improved labour standards, economic advancement and social security", or again, "assurance that all men in all lands may live out their lives in freedom from fear and want", the realization of that support presupposes the whole-hearted co-operation of the American Government and people. Anglo-American co-operation is the first condition of success in the schemes of post-war reconstruction that the International Labour Organisation may be able to prepare.

For this reason the proceedings of the Conference have rightly been viewed against the background of the Atlantic Charter with all the new hope of social security implicit therein. The report of the acting director, Mr. E. J. Phelan, on "The I.L.O. and Reconstruction", advocates the formulation of a social mandate which would represent an important step in preparation for the fulfilment of the great social aims to which Great Britain and the United States are committed in the Atlantic Charter. Mr. Phelan suggests that at a turning-point in the world's history when the general social objective of economic security is to be the mainspring of concerted political effort, the Organisation should be solemnly charged with its share of the task, that thereby men and women throughout the world should be given the guarantee that their Governments will vigorously pursue the effective realization of such a policy through its instrumentality. The formulation of such a social mandate would constitute a general declaration of international social policy and would give the International Labour Organisation a programme to implement, completing it with all the detail necessary.

The emergence of the social objective is emphasized by Mr. Phelan in a striking section of the second part of his report dealing with future policy. Leaders in countries not yet directly involved in the War are as committed to the idea that the objective of economic policy should be improvement in general conditions of life as are those of the British Commonwealth and her Allies. Twenty years of experience has testified to the grave inadequacy of labour legislation in the old, limited sense, and economic security itself is not to be interpreted narrowly but rather as the condition which enables men to build, on the secure basis of an assured standard of material well-being, a fuller, richer and a freer life. The Governments of the members of the Organisation, declares Mr. Phelan, seek economic security for all citizens, achieved in a manner which respects individual dignity and liberty; and since this can no longer be provided by the interplay of blind economic forces, self-preservation dictates that national and international policy must be directed deliberately to that end.

Mr. Phelan realizes to the full the gigantic task which the achievement of economic security represents, and the importance of the spirit in which that task is approached. In his survey of the social and economic background, however, he notes repeatedly tendencies or developments necessitated by war-time measures which should facilitate the mobilization of reserves for peace-time aims —the new conception of the duties of employment offices in the organization of a war economy is an example. Moreover, the whole character of the International Labour Organisation makes it natural for any reconstruction conference to turn to the Organisation in the consideration of social questions, and to use the Organisation as part of its machinery rather than attempt to constitute from its own membership a committee in which employers and workers could not easily be represented.

The stress Mr. Phelan lays on the tripartite constitution of the International Labour Organisation in this connexion is noteworthy. The character of its constitution may well be one factor that has been responsible for its survival when other international institutions have proved ineffective and fallen by the way. It is, however, of particular significance when the Organisation is domiciled in North America and much of its activity is concentrated in the Western hemisphere. The succession of strikes in the United States which has recently hampered production is a reminder that in labour relations that great democracy is a generation or more behind Great Britain. It may well be hoped that during its stay in North America, the International Labour Organisation may make important contributions to the establishment of smoother relations between the State and organized industry.

The New York Conference had before it a main report on methods of collaboration between public authorities and employers and workers' organizations, and the publicity which the Conference received should at least assist to make known to American public opinion the rich experience in such matters upon which the Organisation can draw. Moreover, the American people will not have overlooked the stress which Mr. Winant laid, in his valedictory report, upon co-operation between Governments and organizations of employers and workers. Unless such effective co-operation is achieved, said Mr. Winant, the democracies cannot survive.

Mr. Phelan, however, is not content to call for a social mandate in general terms. He sets out for discussion the main points and principles which such a mandate should cover. They include the elimination of unemployment; the establishment of machinery for placing, vocational training and re-training; the improvement of social insurance in all its fields and in particular its extension to all classes of workers; the institution of a wage policy aimed at securing a just share of the fruits of progress for the worker, and a minimum living wage for those too weak to secure it for themselves. Further points are measures to promote better nutrition and to provide adequate housing and facilities for recreation and culture; greater equality of occupational opportunity; improved conditions of work; an international public works policy for the development of the world's resources; the organization of migration for employment, and settlement under adequate guarantees for all concerned; and the collaboration of employers and workers in the initiation and application of economic and social measures.

Action clearly must be taken now on some of these points. Plans for the resumption or increase of the production of articles of general consumption now restricted or regarded as non-essential, plans for the establishment of new industries and the development of new materials and new techniques, such as the greatly increased industrial use of plastics, plans for housing schemes and for public works, both national and international, must be ready, together with the machinery for putting them into operation, if severe and dangerous dislocation of employment is to be avoided when the War ends. Certain forms of international action are likely to be taken to meet urgent needs without waiting for any general reconstruction conference —for example, measures to feed the peoples of Europe. An admirable broadsheet issued by Political and Economic Planning on planning post-war industry has already indicated the extent to which an attempt could be made now to treat the internal demand and supply schedules, even if it could not be fully decided.

This analysis itself gives cogency to Mr. Phelan's general argument. Unless some attempt is made to analyse demand and product, the unemployment situation alone may well once again get out of hand. P E P's attempt to list in very general form some of the questions which must be considered in drawing up reconstruction programmes, and to indicate the kind of principles on which the productive machine can be geared to the satisfaction of needs, is a valuable contribution to the constructive thinking and planning which alone can make possible any effective control of post-war production and distribution over a period of years. Without such control the basic industries will assuredly experience a violent boom followed by an equally violent slump. With control, replacement demands should provide industry with a steady load for some years after the War.

The P E P broadsheet concludes that the authorities responsible could give a lead to industry even at this stage of the War. Guiding principles could be formulated now and the preparation of post-war production programmes commenced. The Government could give the necessary stimulus and practical assistance to industrialists who are thinking of their own future, for it is most essential to decentralize the work behind the planning and the programmes among as many bodies, firms and individuals as possible. Programmes must be considered as a whole, since there are so many industrial inter-relationships to be taken into account. What is really important is that the guiding principles should be formulated as far in advance as possible, for it is the expectations of people which will condition the ease with which they accept particular policies. The expectations formed now will largely shape the future.

Reference is made in the broadsheet to an impressive number of public and private bodies, from Mr. Arthur Greenwood's Reconstruction Committee, Lord Reith's Consultative Panel on Physical Planning, Sir Frederick Leith-Ross's Bureau, Sir William Beveridge's Committee on the Social Insurance and Allied Services and the Inter-Departmental Committee on Demobilisation, to the regional reconstruction organization establishment in Birmingham, Manchester, Leeds, Newcastle-on-Tyne and elsewhere, the committees established by the Royal Institute of British Architects, the Institutions of Civil, Electrical and Mechanical Engineers, and the Reconstruction Department set up by one of the largest aircraft companies, which are making surveys of probable post-war markets and labour and material supply. All are facing one aspect or another of that first important task of domestic reconstruction after

the War—the conversion of British industry from the production of war supplies to the production of the basic needs of a civilized community with the minimum of dislocation, unemployment and social friction. Whether, however, we approach the problem from man-power aspects against the background of demobilization, from the consumer end, as in the broadsheet, or from that of the most effective structure to be given to British industry after the War, even the domestic problem cannot be handled in isolation from the international situation. International organization properly understood, as Mr. Phelan observes, is indispensable to the creation of the conditions in which national freedom can be effectively and safely exercised.

To deal with the social and economic problems which will be encountered at the end of the War, existing national powers will require to be used to the full for national measures. Concurrently, international measures must be taken by the appropriate international bodies if national action is to be effective, and not find itself baffled and defeated by circumstances out of its control. Indeed a real and determined attack on the social problem, the elimination of poverty and the social evils that arise from it, as well as of mass unemployment, and the securing of a higher standard of life for men and women throughout the world involve international action on a greater scale than that of the inter-war period, and greater financial resources to equip and extend international machinery must be forthcoming. Mr. Phelan's report contains abundant evidence to justify the act of faith which summoned the Conference in New York. The attention thus directed to the valuable experience already gained by the International Labour Organisation should lead, to the fuller recognition by all the Governments of the free nations of its effectiveness as an instrument of their declared post-war social policy, to its full utilization for that purpose and to placing at its disposal the necessary resources. Nothing is more certain than that the building of a new economic and social order to satisfy the hopes and expectations that have already been aroused, and to compensate for all the sacrifices now being made in the cause of freedom, will demand not only all the greater powers and resources placed in our hands by science, all the new experience of social and economic controls and of the government of world industries being acquired in our war effort, but also all that rich experience of co-operation between workers and managements and Governments the world over which twenty-two years of service have made available in the International Labour Organisation.

AN INDICTMENT OF CIVILIZATION

Man: The Mechanical Misfit

By G. H. Estabrooks. Pp. xi+251. (New York: The Macmillan Company, 1941.) 10*s*. 6*d*. net.

THE thesis maintained in this book by the professor of psychology in Colgate University, is that civilization is to perish, not by war, but by the action of certain evils which are inherent in our Western way of life. "Let us suppose," he writes, "that this war takes the very worst turn possible. All the countries, including America, are in turn invaded, and their cities reduced to ruins. Hardly possible, but let us suppose it occurs. Even so, it would seem to the writer that the reverse would be purely temporary. We still have ample human brains to reconstruct our culture from memory or from books." In this verdict the reviewer is in agreement with the author.

According to the author, man made a fatal mistake when "some 10,000 years ago," he began to clothe himself in that "glossy stuff called civilization"; it was then he threw overboard Nature's basal law, which Darwin named 'natural selection'. Cromagnon man, who lived in uncivilized times, was the product of "open competition", "an almost perfect man-beast". His successor brought the germs of that most fatal of all human diseases —civilization. Nature had given him a large brain "to aid in the bitter struggle for survival in a ruthless world". Instead, civilized man "side-stepped" Nature and used his big brain to succour the weak. So it has come about, according to Prof. Estabrooks, that our cities are filled more and more with men and women who suffer from hereditary disabilities of brain and body. It is only a matter of time, and civilization must come to an end for lack of people who are fit to carry it on.

This bald statement of the author's main thesis does a grave injustice to the racy and epigrammatic style in which he has presented it. In dealing with serious problems—and the annihilation of mankind by the civilization he has so laboriously created certainly belongs to this order—it is well to strip away the wrappings and get at the contents of the parcel. The chief content is the assertion that, in the human world as in the animal world, natural selection, survival of the fittest, the law of the fang and claw, to use the author's phrase, is the fundamental axiom of Nature. Perhaps the emphasis

which Darwin gave to the law of natural selection has led so many popular writers to overlook the fact that among social animals the qualities of the "heart" are just as potent in the struggle for survival as are claws and fangs. If only Darwin had expanded the brief paragraph I am to quote from his "Descent of Man" into a long chapter, for which he had ample material, the error into which so many writers on human evolution fall would have been avoided. The paragraph is this:

"For these communities which included the greatest number of the most sympathetic members, would flourish best, and rear the greatest number of offspring." (Chap. iv, p. 163.)

We have now good reason to believe that from the very beginning of what may be termed the period of human evolution, men were grouped in local communities, such as Darwin has postulated in the paragraph just cited. The ever-increasing duration of the period of the infancy of the human young rendered the prevalence of the laws of mercy and of co-operation within the groups more and more advantageous. The law of 'claw and fang' also prevailed, but its main objective was the defence of the local community. Pity for the weak was just as much the subject of natural selection as were man's sterner pugnacious qualities. I therefore hold that Prof. Estabrooks is in error when he assumes that our solicitude for the unfit is an attitude of mind introduced among us by civilization.

To this criticism Prof. Estabrooks may reply: "No matter when mankind began this maudlin sentimental care for the unfit, see how the practice works in a modern state." In the United States there are ten million feeble-minded citizens, one million of them confined in institutions. A "college group", 1,000 strong, provides the succeeding generation with only 800 individuals, while one thousand morons contribute 6,000. No State could stand up to such a substitution in its population. Thirty-two of the States have sanctioned by law the sterilization of the hereditarily unfit; the law is a dead letter in all thirty-two States save one. Is this refusal to face a problem in eugenics a manifestation of the "insanity of the sane", as Prof. Estabrooks maintains, or is it the persistence of that instinctive love of mercy mankind brought with it from the jungle—a fear that if it tampers with one part of its birthright, it may lose the whole? I leave the query unanswered; but I believe that in a struggle between two nationalities, one of which nurses humanitarianism within its borders to the full, while the other throws it overboard, it is the humanitarian State which will be the ultimate survivor.

No doubt Prof. Estabrooks is in the right when he maintains that modern civilization has beset the path of its habitués with temptations which were unknown to our uncivilized ancestors. He instances the case of a pair of educated parents, finding they could not afford both a child and an 'auto', decide on the latter. This choice, according to the author, was made under the action of the "pleasure principle, the greatest force guiding human and animal behaviour", a principle which, in the reviewer's opinion, fails to explain several forms of human behaviour. The author, however, does not mention that our uncivilized ancestors—and some of our civilized—had also their temptations. They had to think whether there was food enough to fill a "new mouth" and, if not, solved their problem by the practice of infanticide. A tribe which indulged in this practice beyond replacement rate soon fell a victim to the law of natural selection.

The two most urgent problems which the civilized have to solve are, in Prof. Estabrooks' opinion, (1) the abolition of feeblemindedness and (2) the abolition of war. The solution of the first is "startlingly simple; sterilize all the mentally retarded for just one generation and feeble-mindedness will practically cease to exist"—a result altogether at variance with the verdict given by British geneticists. War he regards as "racial insanity"; it is "a wholesale butchering of our best stock". "Nature's great law, the survival of the fittest, is here not only ignored; it is reversed." Prof. Estabrooks does not give a moment's consideration to the position of a nation whose manhood refuses "the honour of facing the machine gun and tank"; such a nation does not survive; war illustrates the law he so strenuously advocates—the survival of the strongest.

In his preface the author informs us that "this book is intended to represent a point of view—nothing more". Certainly his point of view loses nothing from the vigour and clarity of its presentation. He shares with his colleague Prof. Hooton of Harvard, not only the gift of humour and a faculty for vivid verbal presentation, but also the tendency to gain emphasis by the use of exaggeration. When he informs us that "up to now, education in its broadest sense has been the most potent force leading to human degeneration", we feel he is seeking to produce an effect rather than to inculcate truth. It was by education that Galton hoped to introduce the practice of eugenics.

Notwithstanding my criticism, there can be no doubt that Prof. Estabrooks has written a book with a high and healthy purpose; he seeks to bring home to parents who spend on personal pleasure what should go to the building of a new generation, the guilt of racial embezzlement.

A. Keith.

SPECTROGRAPHIC TABLES

Tabelle der Hauptlinien der Linienspektren aller Elemente nach Wellenlänge geordnet

Von Prof. H. Kayser. Zweite Auflage, neu bearbeitet und herausgegeben von Rudolf Ritschl. Pp. viii+269. (Berlin: Julius Springer, 1939.) 28.50 gold marks.

Massachusetts Institute of Technology Wave-length Tables:

With Intensities in Arc, Spark or Discharge Tube of more than 100,000 Spectrum Lines most strongly emitted by the atomic elements under normal conditions of excitation between 10,000A and 2,000A, arranged in order of decreasing wave-lengths. Measured and compiled under the direction of Prof. George R. Harrison by Staff Members of the Spectroscopy Laboratory of the Massachusetts Institute of Technology assisted by the Works Progress Administration. (A Publication of The Technology Press, Massachusetts Institute of Technology). Pp. xxix+429. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 90*s.* net.

THE appearance of these books is a sign of a more permanent aspect of the times than that which unfortunately must now engage most of our attention. Not only are the tables now before us of great intrinsic importance; they are significant also as a symbol of the transition of atomic spectroscopy from the field of physical theory, where the greater part of its work has now been completed, to that of industry, biology, and other activities in which it can find practical application.

Spectroscopy—spectrum analysis, as it was then called—began as a department of chemistry, but owing to the vagaries which spectra exhibited, arising from little understood variations in the source of luminosity, chemists soon reverted to their more dependable methods, and the practice of spectrum analysis was left for a few decades to astronomers. Stars had to be analysed by their spectra or not at all, and despite many inevitable mistakes, the almost exclusively astronomical period of spectroscopy saw many important advances. It was not until 1913, however, when the Bohr theory indicated the true character of spectrum emission, that the apparent inconsistencies began to be understood, and for the next fifteen years the study of spectra dominated research into the structure of the atom. The knowledge thus gained made spectroscopy a trustworthy instrument for investigating not only chemical composition but also the physical conditions existing in laboratory and industrial processes, the transient existence of intermediate substances during chemical changes, and a variety of other problems to which its relevance had not been suspected. It is in this epoch that we are now well immersed, and its *sine qua non* is the existence of accurate and comprehensive tables of wave-lengths, intensities and identifications of spectrum lines. The volumes under review represent the latest and most complete attempts to provide such tables.

The Kayser-Ritschl volume is a revision of an earlier publication, the general plan of which it retains with some improvements. New lines have been included, and most of the errors of the previous volume have been corrected, though the V line at λ 3876·08 is still given as 3877·08, and the non-existent V line, 6219·55 (apparently an error for 6119·55, which, however, is given), still appears, while the V I and Ti II lines, at 4395·24 and 4395·04, respectively, are each given twice in different places. On the whole, however, the volume seems to have been considerably improved. One great defect of the earlier edition has been corrected by the definite division at about 2,000A. between measurements in air and those in vacuum. Formerly, no indication at all was given of the medium in which lines in this region were measured.

Harrison's book is the first result of an entirely new project, involving the mechanical measurement, by the now well-known instrument installed at the Massachusetts Institute of Technology, of most of the wave-lengths recorded. While Kayser-Ritschl contains about 27,000 lines between 90,000 and 32 A., Harrison gives nearly 110,000 lines within the range 10,000—2,000 A. The much greater 'density' of lines in Harrison is further accentuated by the fact that only lines of neutral and singly-ionized atoms are given, whereas Kayser-Ritschl is not confined within any excitation limits. Furthermore, Harrison very usefully includes 1381 band-heads, identified, however, not by the molecule of origin but by its 'principal' atom, so that the CN bands, for example, are assigned to C. This is an unfortunate "simplification" for which it is difficult to find the justification, unless it be the inadequate one that "the tables are designed principally for use in spectroscopic analysis of materials and for identifying impurities". The publication as a whole, however, is a remarkable *tour de force*, which it is difficult to admire too highly, and of which the value can scarcely be exaggerated. Some idea of the mechanical mastery achieved over a very difficult

problem is given by the statement that "the wave-lengths of more than a thousand lines can be recorded in one minute without difficulty", and it might be added that there is no evidence of any sacrifice of accuracy.

The Kayser-Ritschl data have been taken from what are considered the most trustworthy sources; there has been no averaging of all available figures. This is true also of those of Harrison's wave-lengths which are not original measurements, but, unlike Kayser-Ritschl, he gives the sources in such cases. Kayser-Ritschl's wave-lengths do not go beyond the second decimal, since the disagreement between observers seems to make greater precision illusory. Harrison usually gives a third decimal, but doubts its accuracy. Neither volume gives hyperfine structures. Kayser-Ritschl includes forbidden lines, with their identifications if known and celestial sources if not, but Harrison omits all such lines, even if they have been produced in the laboratory. *Raies ultimes* are denoted in Kayser-Ritschl by the letters LL after the chemical symbol in the main table. Harrison gives no such indication, but lists *raies ultimes* in two separate tables, in order of wave-length and classified under the several elements, respectively. The degree of ionisation when known is given in both volumes by the usual numeral, I, II, . . . placed after the chemical symbol. When it is not known, Kayser-Ritschl places B, F or G (denoting arc, spark, or vacuum tube) after the symbol, and the single intensity number refers to that source. Harrison, however, retains the older method of giving a separate intensity column for each source, though a warning is given that the scales of the columns are not comparable, so that a line given a larger intensity number in the arc than in the spark might yet be enhanced in the spark. Both volumes are well printed, but Kayser-Ritschl is the easier to read. The small Clarendon type used in Harrison needs careful scrutiny to avoid misreading, and, even so, one is liable to confuse Ti and Tl, for example.

Books of this character cannot be satisfactorily reviewed until they have been in constant use over a long period. Two years under abnormal conditions provides less experience than is desirable. The impressions on which this review is based have come mainly from the measurement of plates of a specially prepared *raies ultimes* mixture, containing all the spectroscopic elements except indium and the rare earths, and showing many hundreds of lines throughout the ordinary regions of the spectrum. This work has shown very definitely that the volumes are complementary to one another and cannot properly be considered as alternatives. For most problems, and for preliminary work in all, Kayser-Ritschl is the more useful, Harrison containing too many lines within a short range to do more than confuse the investigator. Suppose, for example, a prominent line appears at a position estimated as between 4020 and 4021A. It will probably be Sc I, which has a *raie ultime* at 4020·40. Harrison, however, gives 29 lines within this range of 1 A., two of which are given considerably higher intensities than Sc I, and others comparable intensities, although, in fact, they are all relatively unimportant lines of their respective elements. Kayser-Ritschl gives five lines, with Sc I as the strongest. Since most workers use small dispersion spectrograms, not permitting the highest accuracy in measurement, Harrison gives little help. For those, however, who have facilities for precise measurement and for whom accurate identification is essential, Harrison may become indispensable. It is claimed that the lines given comprise one-half of those known, and account for 99 per cent of the radiation emitted by atoms within the range of wave-length covered. It is therefore clear that the volume serves better as a means of excluding possible alternatives to an identification adopted than as a ready guide to the identification to adopt.

Incidentally, it may be remarked that an almost indispensable supplement to such tables as these is a table of multiplets of the elements such as is partially provided in Miss Charlotte E. Moore's "Multiplet Table of Astrophysical Interest". The problem of the Sc I line referred to above could probably be settled at once by looking for the other three lines of its multiplet, and taking the relative intensities into account.

The mention of intensities introduces the most glaring defect of both books—the extremely unsatisfactory treatment of the problem of intensity scales. The problem is admittedly very difficult. Obviously no significance can be attached to the relative intensities of lines of different elements when the elements producing them exist in unknown proportions in the source; nor can lines far apart be given directly comparable intensity numbers because of variation of plate sensitivity. Within a single spectrum and a short wave-length range, however, the numbers can be at least in the right order of magnitude, and this order is often the only available factor in deciding a particular identification. How badly the need is met can be illustrated by a single example, chosen before the recorded intensity numbers were looked up, so that it may be taken—as, in fact, it is—as typical of the general chaos. The example is the well-known *DF* sextet of VI, containing the *raie ultime* at 4379, which covers only a short range of wave-length. The following are the arc intensity numbers of the lines in the two volumes, compared with those recorded by Miss Moore in the publication

referred to above, which are based on King's furnace spectra :

	Kayser-Ritschl	Harrison	Moore
4379·24	10*R*	200*R*	150*r*
84·73	120*R*	125*R*	125*r*
89·99	100	80*R*	100
95·24	10	60*R*	80
4400·59	60	60	60
06·65	80	40	80
07·66	70	15*h*	70
08·21	70*R*	30	70
08·52	50*R*	30*h*	90
16·48	20	15*w*	20
21·59	20	30*h*	20
26·01	15	25*h*	20
29·80	15	30	15

This needs no comment, but a word may be added on the desirability—particularly in Harrison, where the lines occur at such small intervals—of making an attempt to give lines of different elements intensity numbers roughly proportionate to their relative prominence in their own spectra. The present numbers are utterly meaningless in this respect. For example, Harrison records two lines of Fe I, at 3243·109 and 3190·651, as having arc intensity 50. These lines are so weak that they do not appear on Buisson and Fabry's well-known map of the iron arc spectrum obtained from almost pure iron and intended as a record of the whole spectrum. On the other hand, the *raie ultime* of W, at 4008·753—in a region where plate characteristics should give it relative prominence—has intensity 45. It is much to be hoped that a satisfactory intensity scale will take precedence of the inclusion of wave-numbers in the future improved tables which Harrison promises.

In spite of all defects, however, these volumes represent an enormous advance over anything of the same character that has preceded them, and they are indeed indispensable in any laboratory in which spectroscopy is applied to practical problems. Spectroscopists everywhere will acknowledge a deep debt of gratitude to the compilers for the care and patience with which they have carried out a very great task. HERBERT DINGLE.

THE EXTRA PHARMACOPŒIA

The Extra Pharmacopœia

By Martindale. Twenty-second edition. In two vols. Vol. 1. Pp. xxxviii+1289. (London: The Pharmaceutical Press, 1941.) 27*s*. 6*d*.

THE first volume of the twenty-second edition of the Extra Pharmacopœia—Martindale—has appeared at about the time that it might have been expected if there had been no war. It looks like its immediate predecessors and, like them, will be almost indispensable to the physician and the pharmacist, who are expected to know all that is new in the way of medicines, whether they be respectable and approved or merely advertised. A great part of the material for this edition had fortunately been collected before the War had cut international communications and slowed up the output of scientific work. More than two thousand new medical and pharmaceutical papers are abstracted and the revision committee has had to put much more of the book into small print to make room for the new matter without making revolutionary changes in the format.

The arrangement of the information still leaves something to be desired, and it is fortunate that there is a good index. Drugs with closely allied actions are generally classified together, but choline, because of its relation to acetylcholine, is discussed in the article on acidum aceticum, which is absurd. Sympathomimetic amines are arbitrarily divided up so that some of them are included with adrenaline and others with ephedrine.

Data from the first three addenda to the British Pharmacopœia, the second supplement to the British Pharmaceutical Codex, the new French and Japanese Pharmacopœias and the new supplements to the United States and Dutch Pharmacopœias are included. Some of the information about proprietary names has been eliminated because the drugs are no longer available in Great Britain. This is unfortunate because it makes the book less complete as a work of reference, without any compensating advantages except a small saving of space. There is no guarantee that the drugs which are mentioned are available; many of them are not.

The amount of information in this book is prodigious, and it is difficult to select examples of the changes that have been made without making out a long list. Sulphanilamide and its derivatives occupy no less than 37 crowded pages. Many new hormones and vitamins have been dealt with and there is much information about such new interests as blood transfusion, heparin, penicillin, chlorophenolic and higher phenolic antiseptics. The section on vaccines, sera, toxins and antitoxins now covers 74 pages. An entirely new therapeutic index has been compiled in which diseases are arranged alphabetically, with a list of the treatments recommended and the pages of the book on which references to these treatments will be found. This index will be very useful to medical men.

The book as a whole gives an interesting picture of the unprecedented advances in therapeutics which have occurred in recent years.

The Revolution in Physics

By Ernst Zimmer. Translated, and with a Preface, by H. Stafford Hatfield. Pp. xv+240. (London: The Scientific Book Club, 1941.) 2*s*. 6*d*.

THERE are almost numberless little books written to help the layman to understand modern physics. At first sight this modest volume is yet another. But not quite. It deals, as they all do, with the rapid development of physics, indicating how it is that our concepts have become less and less mechanical. But here the similarity ends. The usual course is to make up for so much hard going by generous quantities of applied science, wireless, television, and other 'benefits'. In this book the author, however, decides otherwise. He makes a moving, almost passionate, appeal for pure knowledge, without thought of application, still less of reward. The whole outlook is remarkably unselfconscious, and, for that reason alone, most refreshing. Prof. Max Planck's short introduction is characteristic and charming.

Naturally enough, the writer is a little pedestrian in his dealings with the classical quantum theory, but very much the reverse in his discussion of positivism, determinism and Heisenberg's Uncertainty Principle.

There are a few typically Teutonic lapses; for example, Clerk Maxwell is described as "English"—more than sufficient to cause the first Cavendish professor to rotate in his grave. It is hard to judge of the translation without access to the original: on the whole it seems well done. Certainly it is faithfully done, since one gets glimpses both of the author's occasional touches of *Lehrkörperheit*, and yet of his natural facility as an essayist.

F. I. G. R.

The Observer's Book on Meteorology

By William Alexander and W. J. D. Allan. (The Observer's Books, No. 6.) Pp. 110. (London: George Allen and Unwin, Ltd., 1941.) 2*s*. 6*d*. net.

THIS book is written for pilots and observers in the R.A.F., who will find in it much useful information. It is marred by some inaccuracies, over-sweeping generalizations and dubious explanations of phenomena that meteorologists have not yet succeeded in explaining. One of the inaccuracies is probably a misprint—the reference on page 77 to a shallow depression as one above 1,100 millibars. Minor ones that might confuse a student of elementary meteorology include the statement (p. 36) that pressure gradient is usually expressed as the distance in miles between two isobars of two millibars difference in pressure, a quantity that is in fact proportional to the reciprocal of the gradient, and (p. 52) that in the British Isles it is customary to refer to northerly winds as polar winds and southerly winds as equatorial winds; apart from the absence of any necessary connexion between the direction of the wind and its past history there is the contradictory statement (p. 66) that polar air has a tendency to flow in a westerly direction and equatorial air in an easterly direction. In the paragraph on snow (p. 97) the explanation of the formation of snowflakes is unorthodox and unlikely, nor is it inevitable to have rain on the ground when snowflakes fall through a layer of air above 32° F. (Why not sleet?). One would like to know the grounds for attributing (p. 78) tropical cyclones and temperate tornadoes to the same cause. Weather forecasting with the aid of isallobaric charts is not as simple as the account on p. 110 implies, although the changes described sometimes take place.

Our Wonderful Universe

An Easy Introduction to the Study of the Heavens. By Dr. Clarence Augustus Chant. New edition, revised and enlarged. Pp. 281. (London, Bombay and Sydney: George G. Harrap and Co., Ltd.; Toronto: The Ryerson Press, 1940.) 5*s*.

THIS work is written specially for young people and the subject is approached from the observational side: mathematics are completely absent from the text. The copious illustrations will prove very helpful to the tyro as will also some of the simple experiments which have been suggested, for example, the camera and flash-lamp apparatus, described in Chapter 1, to illustrate the rotation of the earth. Part 1 gives a brief outline of the general structure of the universe and Part 2 deals with the solar system, concluding with a short account of the origin of the sun and planets. Reference is merely made to the nebular hypothesis and the tidal theory; in the limited space the author finds it impossible to state any of the objections to either of these theories. In Part 3 the reader will find an excellent account of the stellar systems, proper motions, variable stars, double stars, star clusters, nebulæ, etc. Detailed descriptions are impossible in dealing with such a vast programme in a single volume, but Prof. Chant has succeeded in condensing an enormous amount of useful information into the work, which will stimulate young readers to pursue the subject further in more advanced text-books. The value of the book is enhanced by the illustrations and photographs—210 altogether—which greatly increase the interest in the various sections.

M. D.

The Promise of Scientific Humanism Toward a Unification of Scientific, Religious, Social and Economic Thought

By Prof. Oliver L. Reiser. Pp. xviii+364. (New York: Oscar Piest, 1940.) 4 dollars.

THE author advocates the use of non-Aristotelian logic. This would mean abandoning the laws of identity, contradiction and excluded middle. He claims that such a revolution in thought would eliminate many ancient and modern fallacies, and introduce a new and better era in science, philosophy and social relations. In spite of some good points he fails to make out a case. His exposition is often rhetorical and cloudy; he uses indiscriminately all sorts of opinions, sober and speculative, good and bad; he shows no capacity for critical judgment. Altogether the new non-Aristotelian logic sounds very like the old sophistry that Aristotle's logic was designed to expose.

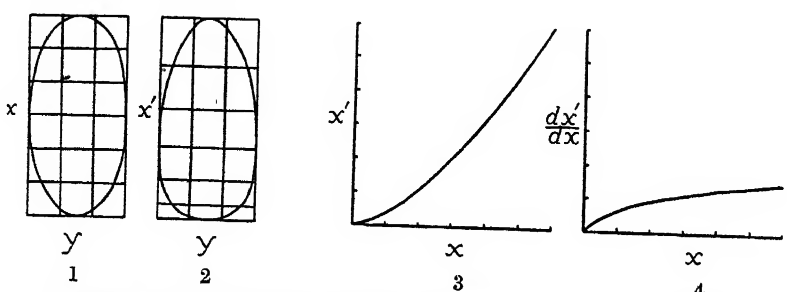
A. D. RITCHIE.

THE 'LAWS' OF BIOLOGICAL GROWTH

By P. B. MEDAWAR

DEPARTMENT OF ZOOLOGY AND COMPARATIVE ANATOMY, OXFORD

THE study of mere increase in size and weight has steadily lost the interest of British students of growth since D'Arcy Thompson[1] and later Huxley[2] directed their research to other fields. Many of the beliefs about organic growth that formerly seemed reasonable or even self-evident—in the existence, for example, of an integral biochemical process known as 'growth metabolism'—have now been refuted or superceded; and it is only quite recently that students of growth have stopped applying to the organism the fiscal concept of interest, or increments of size, accumulating at finite intervals. Minot[3] always used it. The inspection of curves of growth has nevertheless made known a number of general principles concerning the dependence of the size of organisms on their age which it is very worth while to collate and comment upon. These laws are of the growth of *individual* organisms. It was Davenport[4] who first pointed out the unsuspected extent to which curves of growth compiled from mass statistics may be corrupted by what are in reality curves of distribution. At puberty, for example, the growth of individual boys shows a marked spurt, the time of onset of which in the male population as a whole is normally distributed about a mean value at approximately $14\frac{1}{2}$ years. The 'adolescent growth component' of the mass curve of human growth, to which Robertson[5] fitted his well-known 'monomolecular autocatalytic' function, does not occur in the curve of individual growth. Davenport showed that it was essentially a modified Gaussian curve of error, indicating the distribution in time of the onset of adolescent growth spurts.



ILLUSTRATING THE TYPE OF CHANGE OF SHAPE BROUGHT ABOUT BY A SIMPLE GROWTH GRADIENT.

The transformation from an elliptical to an ovoid outline is illustrated by the grids superimposed on Figs. (1) and (2). The ordinates or x'-values in (2) are those which correspond to *integral* values of x in the normal grid (1). In (3) the 'mapping function' $x' = f(x)$ which defines the transformation is plotted in the usual way; its essential feature, as (4) shows, is that the slope of the curve $x' = f(x)$ never decreases as x increases.

The laws themselves require a varying amount of critical attention. Each describes a general trend of growth; they take into account neither short-term fluctuations or periodicities, as in animals with an annual cycle of growth, nor more pronounced singularities, such as those brought about by metamorphosis in animals which undergo it. Unlike some mathematical approximations, they lose accuracy and significance in proportion as the period of time over which they are intended to apply becomes shorter. Nor do these laws apply over the whole of the life-cycle. They should be taken to refer to the 'functional period' of development, namely the period which begins with the blocking-out of the main organ systems in the embryo.

1. *Size is a monotonic increasing function of age.*

Less formally, organisms do not decrease in size as they grow older. A more casual statement, such as that 'organisms increase in size as they increase in age', would be much less satisfactory, for it could be shown to entail an unproved belief, namely that in the course of their development organisms approach a limiting size. It is plausible to suppose that they do so, and most of the functions commonly used to describe the course of growth are functions with limiting values. But it is important not to exclude, at all events in a formal way, the possibility that organisms reach a *maximum* size at which they remain virtually stationary during the latter part of their life.

2. *What results from biological growth is itself, typically, capable of growing.*

Biological growth is fundamentally of the multiplicative type: that is the only 'law of growth' commonly recognized as such. It justifies the almost universal use of the relative differential $dw/Wdt = d/dt\ (\log_e W)$ as the one most likely to give a significant expression of change of size. The estimate it provides is of the *specific growth-rate*, and the special instance of growth by the compound

interest law corresponds to a uniform specific growth-rate.

3. *In a constant environment, growth proceeds with uniform specific velocity.*

The truth of this important principle, with its Newtonian flavour, has been demonstrated on a number of occasions, perhaps most clearly by Richards[6] for population growth in colonies of yeast. The 'constancy' which the law requires is not only of the external environment, but of the *milieu interne* as well. Outside work must be done on a growing system if its environment is to remain constant, and since the *milieu interne* of complex organisms is not accessible to the sort of experimental control which is required, it is only tissue-cultures and populations of non-cellular organisms which can be induced to grow 'logarithmically' for any significant length of time. The fourth law, then, relates the second to conditions which actually hold in the development of many-celled organisms.

4. *Under the actual conditions of development, the specific acceleration of growth is always negative.*

While the growth-rate may rise and then fall, as it does in any organism the growth of which is described by a sigmoid curve, the *specific* growth-rate always falls. There are few, if any, exceptions to this general rule. Roughly speaking, it means that 'what results from biological growth', although capable of growing, is not capable of growing as fast as its precursor. Minot regarded the degree to which it fails to do so as a measure of senescence. Senescence is therefore a process taking place continuously throughout life. This is Minot's great contribution to biological thought.

5. *The specific growth-rate declines more and more slowly as the organism increases in age.*

The specific acceleration of growth $d/dt\ (dw/Wdt)$, while always negative, rises progressively to zero during the course of life. In short, 'organisms age fastest when they are young'; or, to put it in a more familiar way, they develop more slowly as they grow older. The rate at which the specific growth-rate declines is an important parameter in any equation for growth, and its value can in certain circumstances be measured by purely experimental means[7].

These laws provide a fairly stable background for the quantitative analysis of growth. An obvious omission is of an expression for the differential growth of the parts of an organism, or of parts in relation to the whole. One possibility, which has been examined exhaustively by Huxley, is that the specific growth-rates of comparable parts of an organism bear a constant ratio to each other throughout the greater part of life. This relationship has been described as 'simple and significant'; and what it chiefly signifies is that senescence, measured by the rate at which the specific growth-rate declines, proceeds at an approximately uniform rate throughout the organism. This latter theorem, which is far from self-evident, and which might have been the most important *inference* from any established facts concerning constant ratios of specific growth-rate, was treated by Huxley as one of the *axioms* he used to provide a deductive basis for the doctrine of constant specific growth-rate ratios in general. A more general and far-reaching statement about growth-rate patterns is Huxley's theorem that, typically, the particular growth intensities of the parts of an organism are spatially arranged in an ascending or descending order of magnitude. Organisms which conform to this pattern may be said to 'exhibit a growth gradient'. The generality of the gradient pattern reflects our conviction that a large part of the physics of development is primarily a physics of diffusion. This is the chief physiological importance of the theory.

The gradient theory may also be used to define, within broad limits, the *type of change of shape* which occurs during the developmental growth of an organism or of one of its parts. For the transformations which can be designed to assimilate any two shapes adopted by a developing organism can, in principle, be defined by a substitution of variables in the equation which describes one shape or the other. The new variables are functions, sometimes called mapping functions, of the ones they replace. Transformations are defined by the properties of these functions. The gradient theory restricts the mapping functions which define the transformations of development to membership of a large but distinct class. Consider, for example, an axial gradient of growth which distorts the outline of an organism in one dimension only. If $F\ (x, y)=0$ describes the original outline, the new outline will be represented by the equation $F\ (x', y)=0$, where the key to the transformation is the mapping function $x'=f(x)$. The gradient theory, strictly interpreted, merely requires dx'/dx to be a monotonic function of x. In other words, the characteristic mapping function is one of which the first derivative is a monotonic function of one or the other of the original variables.

By a natural extension of this interpretation, the gradient theory can be generalized to admit transformations which are the *products of* transformations so defined. The product of one transformation with another is the result of applying one to the result of applying the other, and it should usually be taken in a definite order. In generalized form, the theory therefore states that complex changes of

shape can be significantly resolved into simple changes of shape of the type defined above. The word 'significantly' is meant to express our assurance that the whole procedure is not merely an analytical device, but that the product of transformations corresponds to the combined or successive action of distinguishable physiological processes.

This interpretation of the gradient theory, which will be given a fuller treatment elsewhere, relates it to the more comprehensive methods of analysing organic form which were designed by D'Arcy Thompson. The danger of over-simplification is of course very real: for example, the outline drawings of animals with which we are obliged to start our analysis of shape are themselves affine transformations of the three-dimensional objects they represent. But once they have been recognized as such, our purely informal simplifications and assumptions lose a great deal of their virulence. There is something more in the analysis of growth-rate patterns than a determination to see order where no order exists.

[1] Thompson, D'Arcy, "Growth and Form" (Cambridge, 1917).
[2] Huxley, J. S., "Problems of Relative Growth" (London, 1932).
[3] Minot, C. S., "The Problem of Age, Growth, and Death" (New York, 1908).
[4] Davenport, C. B., *Coldspring Harbor Symposia*, 2, 203 (1934).
[5] Robertson, T. B., "The Chemical Basis of Growth and Senescence" (Philadelphia, 1922).
[6] Richards, O. W., *J. Gen. Physiol.*, 11, 525 (1928). Richards uses the term 'constant growth-rate' in the sense in which 'constant specific growth-rate' is used here.
[7] Medawar, P. B., *Proc. Roy. Soc.*, B, **129**, 332 (1940).

LIFE AT HIGH ALTITUDES

By PROF. A. J. CARLSON
UNIVERSITY OF CHICAGO

MEN of science at the symposium on "Life at High Altitudes and Aviation Medicine" held at the University of Chicago on September 23 as part of the University's fiftieth anniversary celebration heard dissertations ranging from a description of an "Altitude Human Race" to the physiology of the free fall and of parachute jumping.

Since fright, rather than basic physiological reactions like blood pressure or heart action, is one of the chief causes of fainting in a delayed-opening parachute jump, use of a small guide parachute which prevents twisting and spinning in mid-air—conducive of fright—will contribute much to the safety of parachute jumpers. In addition, the 'anti-spin' chute prevents tangling with the parachute lines which sometimes occurs, if the parachutist is twisting when he pulls the rip cord.

These points, given particular emphasis by the strategic military desirability of delayed-opening jumps, were made by Prof. Andrew C. Ivy, professor of physiology and pharmacology in the Northwestern University. Prof. Ivy reported research in collaboration with Prof. Anton J. Carlson, of the University of Chicago, in a paper on "The Physiology of a Free Fall through the Air".

It is worthy of note, pointed out Prof. Ivy, that the person who is in a position where a delayed fall is advantageous would be given confidence by the early opening of the accessory, 'anti-spin' parachute, and this, plus falling in a more natural, or semi-erect posture, would decrease the likelihood of inexperienced persons fainting from fright.

It is Prof. Ivy's belief that when it is necessary to bail out of an aeroplane, a delayed opening of the parachute has certain strategic advantages: the jumper is less likely to foul another jumper, an aeroplane out of control, or falling aeroplane parts; an open parachute is an excellent target for the enemy; if the parachute is opened at an altitude of thirty thousand feet or more the jumper may lose consciousness from lack of oxygen unless he carries a supply with him; if the aeroplane is moving rapidly and the parachute is opened soon after leaving the plane, the jumper is likely to be injured and the parachute and its attachments ripped. When a person jumps from an aeroplane, his rate of fall decreases or increases to an approximate rate of 120 miles per hour. At 300 miles per hour the shock load to the jumper and the parachute is five thousand pounds.

In experiments covering five jumps with a human subject, Mr. A. H. Starnes, following earlier experiments with dummies and apparatus, verified that:

(1) Except in flights as fast as would be experienced in a jump from a descending dive bomber, there is no appreciable unfavourable influence on heart-rate and blood pressure.

(2) A fleeting mental 'black-out' occurs shortly after the jerk of the riser straps caused by the chute opening. Otherwise in a calm and unfrightened jumper, mental reactions are clear, rapid and normal.

(3) The same difficulty in hearing was found as is experienced facing, or with the back to, a high wind. Vision was not impaired when goggles were worn ; the eyes watered without goggles.

(4) There was no feeling of nausea even in spinning, because of the brevity of the time. (The longest drop was 16,500 feet at 158 miles per hour, which took seventy-one seconds.)

(5) Contrary to the findings of Dr. H. G. Armstrong of the U.S. Army, there was no sensation of floating in space when the eyes were closed. Subjectively Mr. Starnes was aware of the drop because of the wind rush and other sensations. He "felt that he was falling, and falling rapidly".

The "Altitude Human Race", a biological entity differing radically in several respects from other branches of mankind, was postulated to describe the dwellers of the Andes mountains of South America by Dr. Carlos Monge, of the University of San Marcos, in Lima, Peru.

Listing a score of vital differences between the man of sea-level and the man of the Andes, living at 10,000–16,000 ft. above sea-level—Mt. Whitney, highest peak in the United States, is 14,495 ft. ; there are thirty-three South American peaks higher than seventeen thousand feet, the highest, on the Chile-Argentine border, Mt. Aconcagua, 22,834 ft.—Dr. Monge also described the disease 'chronic mountain sickness', which afflicts lowlanders when they start to live in the high altitudes.

In the Andes, Dr. Monge pointed out, twelve million persons are living all the time under conditions at an altitude where the oxygen pressure is 85. mm as contrasted with the sea-level pressure of 150 mm.

Describing the high-altitude human race, Dr. Monge said the heart of Andean natives actually beats more slowly following exertion. It seems that increased vagal action causes the bradycardia, which may be considered the law of the altitude heart. We find all the conditions of athletic heart. Chronic anoxia (lack of oxygen, such as that characterizing high altitudes) is a permanent stimulus to improve heart efficiency.

Dr. Monge suggested that this man has some of the biological characteristics needed for an aviator, and that perhaps a better knowledge of the physiology of the man born and living at fifteen thousand feet would help the learning of the required conditions of fitness for high-altitude flight. Since 1928, Peruvian aviators have flown over the Andes continuously at higher than fifteen thousand feet elevation.

Comparing the acclimatization of high-altitude dwellers to the instinctive force which causes the annual migrations of birds, Dr. Monge cited the factor of altitude as one which in the recent Bolivian-Paraguayan war "killed more people [high altitude soldiers made to fight in the lowlands] than the enemy's bullets". The day will come, he pointed out, when these vital matters will receive due consideration for the welfare of the altitude human race.

Men of the Andes may be considered as belonging to a special climato-physiological variety of the human race. In fact they are closely related to their geographical surroundings : altitude, radiation, humidity, ionization, and so on. The sociological behaviour of such men and the telluric (earth-related) environment appear as a whole, as a biological system which cannot be divided, as a climato-physiological unity. They have to adapt themselves on coming down to the coast ; they cannot always stand the meteorological conditions of lower lands ; they become predisposed to disease of the lungs, as has already been reported by Dr. Monge.

But the struggle for life obliges them to come down ; and then ensues a fact which is worth noting. Every year about one hundred thousand men come down to sea-level for agricultural work, but after about three months they go back to the altitude. They never stay at the coast no matter what it offers them.

These peculiar annual human migrations of high-plateau societies are a very well-known fact of biological significance. "Like the swallows, Andean men have the sense of returning home". Therefore, they have the same problems of acclimatization to face when going down to a land not always fitted for their physiological equipment. Usually acclimatization at the coast is easier than that on the highlands. But there are the facts, the study of which is of utmost importance for the knowledge of Andean populations.

How the body mechanisms which constantly tend to maintain the vital balance between acidity and alkalinity adjust to high altitude by stimulating increased breathing, but offsetting the chemical effects of this increase on the blood, was reported by Major David B. Dill, of the U.S. Army Air Corps. Major Dill spoke on "Acid-Base Balance in High Altitudes".

Reporting the Andean expedition to Chile in 1935, in which members of the expedition lived at 17,500 ft. and worked at 18,000 ft., Major Dill described the "beautiful integration of the mechanisms of the organism which combat disturbances of the balance arising from abrupt and prolonged exposure to oxygen deficiency".

In the long-run process of acclimatization, when the acid-base relation is thrown out of equilibrium because of limited availability of oxygen, he said, the increase in the number of red blood cells (oxygen carriers) makes it possible for arterial blood to take up as much oxygen as at sea-level.

In the short-run compensation for acute oxygen shortage, Major Dill listed four steps by which the balance is temporarily maintained: the reduced oxygen in the arterial blood stimulates increased breathing by the action of the carotid body, a small emergency mechanism lying beside the carotid artery (in the neck); this raises the oxygen content of the blood, but causes an increase in alkalinity; this excess is absorbed through the buffering capacity of body proteins, thus relieving the inhibition which alkalosis characteristically exerts on the respiratory centre in the brain, producing a balance between the activity of the respiratory centre and the carotid body.

The chain of events involved in acclimatization (as contrasted with short-run compensation) has been seen to involve a series of reactions:

(1) Lactic acid in the blood remains unchanged while at rest.

(2) After the first few hours of adjustment, the saturation of oxygen in the arteries attains a constant level.

(3) Lung ventilation is maintained at an increased rate.

(4) Arterial blood, after initial alkalinity, eventually assumes its usual reaction.

(5) Both free and combined carbon dioxide in the blood are reduced, but the ratio between them (which governs the respiratory centre) is eventually restored to its usual value.

Taking part in these reactions, Major Dill pointed out, are the lungs, the respiratory centre, the carotid body, the blood-forming tissues, and the kidneys. The over-all result is that man, without taking thought, is enabled to live and work in an atmosphere that contains only half as much oxygen as at sea-level.

Although in experiments in which atmospheric pressure was reduced to one-sixth its sea-level value, the exchange of gases in the lungs goes on as usual, it must be admitted that the possibility of a disturbed acid-base balance exists at any altitude above thirty thousand feet if the period of exposure is long enough. Decompression illness, or bends, may be experienced. If this affection becomes acute, one sees increased respiratory volume, and unless return to lower altitude is prompt there may be circulatory failure and collapse.

The symptoms here seen are like those of shock at ground-level. The stimulus to the respiratory centre presumably originates from a diminished blood supply to the brain and the accumulation of carbonic acid in the respiratory centre. With return to low altitudes, relief is usually prompt.

OBITUARIES

Dr. E. S. Beaven

THE passing on November 12 of Dr. Edwin Sloper Beaven at the age of eighty-four, after a brief illness, will be deeply regretted by a wide circle of friends in Great Britain, and by many in other countries to whom he was known either by personal contact or through his published works.

Dr. Beaven was born near Heytesbury in Wiltshire, and for the greater part of his life resided in the neighbouring town of Warminster, where he carried on the business of malting. Early in his career Beaven became associated with Messrs. Arthur Guinness, Son and Co., the celebrated brewers, an association which influenced the science of brewing, and more particularly all aspects of barley production in the British Isles, in a remarkable manner.

As a maltster the involved question of quality in malting barley attracted Beaven's inquiring mind, and one of his earliest investigations, carried out in collaboration with his friend Dr. J. M. H. Munro, dealt with conditions influencing this important attribute.

But Beaven came of yeoman stock, and it was not long before the convictions engendered by such an ancestral background led him to extend his investigations to the many questions affecting the production of barley. Thus, starting first in the garden of his residence, and later on a more extended scale on land acquired for the purpose, Beaven began a series of nursery and field experiments, now world-famous. These investigations, started on his own initiative, and continued for a period of more than half a century, entirely at his own expense, were a consuming interest throughout his long life. Largely because of the care in execution and then in the clarity of exposition of the results derived therefrom, the experiments at Warminster have for many years been a source of inspiration to visitors from all parts of the world.

One of the most valuable features of the material gathered together at Warminster with meticulous care and patience, was a world collection of species and varieties of barley. This material eventually formed the basis of an authoritative classification of the genus, published by Beaven in 1906, which remains a standard exposition of the subject.

Beaven's most active years coincided with the reappearance of Mendel's theory of heredity, and he applied the new conception enthusiastically in the production of improved varieties of barley. Early in the century he began a long series of hybridizations that culminated in the production of the now well-known and widely grown variety Plumage-Archer. This barley, which will always be honourably asso-

RECENT SCIENTIFIC AND TECHNICAL BOOKS

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ciated with Beaven's name, exemplifies one of the few successful attempts to secure high grain productivity, allied with high malting value.

In the course of the development of Plumage-Archer, the necessity of a small-scale system of yield testing became insistent. To this Beaven applied himself with characteristic thoroughness, and eventually evolved the chequer board system, which with some modification is now widely employed by plant breeders, and later the drill-strip system for testing larger quantities of material on a field scale.

Beaven's interest in all aspects of barley production, both at home and abroad, was unbounded. No journey was too long, if at the end he could see something new or verify the basis of some conclusion he had arrived at. His audience was consequently always a large one, and because of his enthusiasm, always appreciative.

Despite the many calls of his business, Beaven took a keen interest in all activities directed to the improvement of agriculture, to which he himself had contributed so signally. He was present as a member at the first council meeting of the National Institute of Agricultural Botany in 1919. In 1929 he was elected chairman of the Council; he served again in the same capacity in 1939, and owing to the outbreak of war retained this position during 1940, and up to the date of his death. In 1932 he was chairman of the Farmers' Club.

Beaven's work in furthering the science of crop improvement was recognized by the University of Cambridge, from which he received the honorary degree of LL.D. in 1922. He was awarded the Horace Brown Gold Medal by the Institute of Brewing in November 1930.

Beaven's personality will remain a vivid memory to his friends and acquaintances. Apart from a boundless enthusiasm for his particular subject, his outstanding characteristics were a directness of approach to a problem, an independent outlook, and a fearlessness and tenacity in maintaining his point of view. He possessed a keen sense of humour, and although always severely critical, his generosity of feeling, particularly to youth, was unfailing.

Beaven owed much to the influence of a happy family life, and sincere sympathy is extended to his widow and to three daughters who survive him.

HERBERT HUNTER.

We regret to announce the following deaths:

Prof. Phillipo Bottazzi, formerly professor of physiology in the Universities of Genoa and Naples, aged seventy-four.

Prof. Carrie M. Derick, emeritus professor of morphological botany and genetics in McGill University, on November 10, aged seventy-nine.

Prof. H. S. Hower, head of the Department of Physics in the Carnegie Institute of Technology, on October 10, aged sixty-four.

Dr. J. A. Nelson, formerly research entomologist in the U.S. Department of Agriculture, on August 9, aged sixty-five.

Prof. W. A. Noyes, emeritus professor of chemistry in the University of Illinois, on October 24, aged eighty-three.

Dr. J. S. Owens, well known for his work on atmospheric pollution, on December 6.

Prof. Peter Sandiford, professor of educational psychology in the University of Toronto.

Prof. Hans Spemann, professor of zoology in the University of Freiburg-im-Breisgau, aged seventy-two.

NEWS AND VIEWS

Administration in International Affairs

THE Sydney Ball Lecture on "Administrative Problems of International Organization", delivered by Mr. F. P. Walters, which has now been published as Barnett House Paper No. 24 (Oxford University Press. 1*s*. net), is highly relevant to the tentative discussions on post-war international reconstruction which are now proceeding. On the grounds both of efficiency and economy, the advantages of a central organization at the service of all the special staffs required are obvious, and Mr. Waters postulates further that some such centre as Geneva and an annual meeting similar to the assembly of the League of Nations, as well as the secretariat, will be required before dealing with the special problems of administration concerned with the organization of an international centre and its relations with participating Governments. He stresses first the value of a separate department for League affairs, the need for which would have been more apparent in Great Britain but for the general efficiency of the Civil Service and the exceptional ability and energy of officials in the Foreign Office—a tribute from a League official which should be noted. He suggests further that the League budget should include an appropriation for ten or fifteen officials to be seconded each year from the Foreign Offices of different countries to spend six months or more in the secretariat, and he lays a great deal of emphasis on the advantage of cost of membership of committees, travelling expenses of delegations, general expenses of council meetings, the Assembly, and of conferences or special commissions being borne by the League budget as a whole and not by individual States. Similarly, he urges that assistance and advice given through the League or the International Labour Organisation should generally be regarded as a proper charge on the common budget.

The main point throughout Mr. Walters's review of the administrative side of international organization is that such work should be adequately financed. To starve it as has been done in the past may have

been a vital factor making the difference between failure and success. Mr. Walters suggests that an expenditure of from two to two and a half times the average expenditure of the last twenty years might have meant an increase in prestige and activity which would have meant success and not disaster. He considers that the sectional organization of the League secretariat has proved its value, as well as the planning of that secretariat on international rather than on national lines. Its morale has come creditably through a heavy test, and it has proved surprisingly easy to get people to undertake work for the League. The official attitude adopted by members of the secretariat has been fully justified. Apart from Mr. H. R. G. Greaves's study of the League committees, the administrative side of the League's work has received comparatively little attention, and the concentrated wisdom of this lecture should be sure of attention from all those who are giving close study to problems of international organization.

Mass Psychology and the 'New Order'

IN a paper in the *Journal of Social Psychology* (11, 59–77; 1940), Prof. Vyscheslevzeff, of the University of Geneva, maintains that modern sociology cannot function, nor contemporary upheavals be understood and 'new orders' firmly established without the application of collective psychology, notably that of Jung, and especially his "collective" ("common to all men") Unconscious. Dürkheim's view that the good lies in collective forms and division of labour is refuted by quoting Jung on the deformation of personality by specialization, which is held to be not really civilization but barbarism. The antinomy in classical German sociology of *Gemeinschaft* (community) and *Gesellschaft* (society) is particularly stressed. The former has the inner solidarity of, for example, the family or clan, and is characterized by a "collective unconscious", that is, the inherited propensities and archetypes of Jung; the latter is more like a constructed machine, that is, is artificial, and characterized by "collective conscious" (rationality). But they conflict (cf. Engels in the more limited economic sense), like the unconscious and conscious (including the 'personal' unconscious) in the mind of the individual. The problem is to harmonize this sociological conflict by a kind of fusion.

Prof. Vyscheslevzeff indicates that the conflict does not appear on the surface in Soviet communism because the *Gemeinschaft* has been eliminated or rather repressed (by the State), communism being solely rational, unreligious, non-traditional and non-mythical. But the paper under review was written before the outbreak of war and it might be suggested that the invasion of Russia has resulted in a re-emergence of *Gemeinschaft* and may possibly modify Soviet communism, spiritually at least, in the future. In Germany it seems to be implied that the two sociological group-categories exist side by side, in spite of leadership, for example, "racial superiority", "back to Wotan", etc., and "German organization". In looking for a nation which has succeeded in harmonizing the conflict, Prof. Vyscheslevzeff instances England, the Anglo-Saxon culture. "Only thus is it possible to understand the unusual adherence to tradition, to patriarch forms, to ancient symbols, to religion, to habit, together with a belief in progress, the striving for maximum rationalisation and ordering of all realms of life, everywhere bringing in the element of conscious purposefulness. . . . England presents an astonishing synthesis of 'community' and 'society': the collective unconscious with the collectively-apprehended and organised freedom." This view would seem to merit the attention of those who may desire to see a radically new order in Great Britain after the War.

Health of New Zealand

ACCORDING to Dr. M. H. Watt, director-general of health for New Zealand, the year 1940–41 was on the whole the most favourable for health that the Dominion has had. Infantile mortality of the European population fell to 30·21, of which 22·03 is accounted for by 722 deaths in the first month of life. Of these, 606 occurred in the first week and another 72 in the second week. In 330 deaths among the new-borns prematurity was the only cause of fatality. The death-rate from tuberculosis among the Europeans was only 0·388, which is a low record for New Zealand and probably for any country, but this disease came next to cardio-vascular disorders, cancer and violence among the causes of European mortality. Among the Maoris the mortality from tuberculosis was 4·132 out of a total mortality of 17·51. Although syphilis has always shown a low incidence among both Europeans and Maoris, it is increasing in both, especially among the latter. Hydatid disease is more prevalent in New Zealand than in any other country, 120 new cases with 16 deaths being expected every year. The low incidence of endemic disease during 1940 was shown by the fact that there was only one death from measles, and 11 deaths from Flexner dysentery among 161 cases. There was a fall in maternal mortality from 3·64 in 1939 to 2·93 in 1940 due mainly to decline in fatality of puerperal sepsis and septic abortion. The total European births shrank from 27,881 in 1927 to 23,935 in 1935, when the birth-rate reached the low level of 16·17. Among the Maoris, on the other hand, the number of births increased from 1,495 in 1927 to 4,265 in 1940, and the rate from 23·22 to 46·87, while the infantile mortality in 1940 was 87·22 and the general death-rate 17·51.

Smallpox in the United States

ACCORDING to the June issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company, of New York, there were fewer cases of smallpox in the United States in 1940 than in any previous year on record. The 2,839 cases reported represented a drop of more than 70 per cent from the previous year, and were little more than half the total reported in 1934, the previous record low year for smallpox. In an area containing one quarter of the population, namely, the New England States and

the Middle Atlantic States plus Delaware, Maryland and the District of Columbia of the South Atlantic Division, not a single case of smallpox occurred in 1940. In that year, as in every year, the majority of cases were reported in the north central area and in some of the western States. In most of these States large numbers of people disregard the danger of contracting smallpox, and minimize or ignore the efficacy of vaccination. On the other hand, in the neighbouring country of Canada, smallpox has been practically eliminated, as is shown by the fact that in 1940 there were only eleven cases and no deaths, while in eighty-seven cities there was not a single case.

Psychiatry in Sweden

IN a recent address (*Nordisk Med.*, 10, 1921; 1941) at the opening of the new Psychiatric Clinic at the Caroline Hospital, Stockholm, Dr. Viktor Wigert gave a retrospect of clinical psychiatry in Sweden during the last hundred years. In 1844 it was stated by the authorities in charge of the hospitals in Sweden that no expert knowledge was required for the treatment of insanity, which was therefore no concern of public health. This pronouncement had been occasioned by a demand made by a Royal Commission headed by Dr. Carl Ulrik Sondén that all institutions to be built for the care of the insane should provide for the treatment as well as for the confinement of the patients. Sondén, who was a pioneer in Swedish psychiatry, was the first to emphasize the importance of instruction in this branch of medicine, which was introduced in Sweden by Dr. Nils Gustaf Kjellberg, at the Uppsala Asylum in 1859. Kjellberg was an eminent man of science, who as early as 1863 expressed his conviction of a causal connexion between syphilis and general paralysis. In 1861 psychiatry was made a compulsory subject for the medical student in Sweden. In the 'nineties demands were made, particularly by Prof. Frey Svenson of Uppsala and Dr. Bror Gadelius of Stockholm, that special clinics for instruction in psychiatry should be created and that professors of psychiatry should be relieved of their duties as senior physicians to large asylums. Opposition to this demand, however, was not overcome until 1928, when it was decided to open a psychiatric clinic at the Lund University Hospital. The establishment of a similar clinic at the Uppsala University Hospital has since been decided upon, but this has not yet been completed. The psychiatric clinic recently established at the Caroline Institute of Stockholm finally realizes Sondén's desire for an institution for the cure of mental diseases.

War and Birds

ONE of the most noticeable effects of the war-time conditions upon British bird-life has been the rapid increase of magpies, judging from reports in many parts of the country. Much larger flocks than usual have been seen in many counties, like Cheshire, but there is no evidence of any harmful effect. The cessation of game preservation and 'vermin' shooting is the chief cause, and the jay, carrion-crow and sparrow-hawk have shown increases from a similar cause. The felling of woods on a large scale is, however, affecting the distribution of the long-eared owl, woodcock, heron, rook, hawfinch as well as some of the woodland mammals and rarer birds of prey. Efforts to locate hobbies breeding in Wiltshire in 1941 failed.

The Night Sky in January

THE moon is full on January 2d. 15h. 42m. U.T. and new on January 16d. 21h. 32m. Lunar conjunctions with the planets occur on the following dates: Mercury on January 18d. 5h., Mercury 4° S.; Venus on January 18d. 13h., Venus 2° N.; Mars on January 24d. 8h., Mars 5° N.; Saturn on January 25d. 17h., Saturn 3° N.; Jupiter on January 27d. 10h., Jupiter 5° N. On January 21d. 1h. Mercury is in conjunction with Venus, Mercury being 6·2° S. Mars, Jupiter and Saturn are well placed for observation during the night, and Saturn's ring system is well presented for observation. Venus can be seen in the evening hours in the west and does not set until 19h. in the middle of the month. The earth makes its closest approach to the sun on January 2. The Quadrantid meteor shower is active on the first few days of January: the radiant is at R.A. 5h. 24m., Dec. 51° N., but this shower is not usually very conspicuous. On January 26d. 22h. 17m. there will be an occultation of γ Tauri, mag. 3·9. During the month the interval from sunset to sunrise in the latitude of London shortens by 1h. 12m.

Announcements

THE following officers of the Iron and Steel Institute have recently been elected: *President*, Mr. James Henderson; *Vice-president*, Dr. Andrew McCance; *Hon. Treasurer*, The Hon. R. G. Lyttelton; *Members of Council*, Prof. J. H. Andrew and Mr. N. H. Rollason. Mr. Walter S. Tower, president of the American Iron and Steel Institute, has been nominated an honorary member of the Institute, and the presidents of the Sheffield Society of Engineers and Metallurgists and of the Sheffield Metallurgical Association have been appointed honorary members of the Council.

CATALOGUE 27, entitled "Science", has recently been published by Ifan Kyrle Fletcher, late of 26 Old Bond Street, London, W.1, and now of Merridale, Caerleon, Mon. It contains lists of old books on astrology, chemistry, mathematics, medicine and physics, as well as important works on civil and marine engineering from the library of Sir William Cubitt (1785–1861). Among the books of special interest and rarity are William Beaumont's "Experiments and Observations on the Gastric Juice and the Physiology of Digestion" (1833), Thomas Vicary's "The Englishman's Treasure with the True Anatomie of Man's Bodie" (1599), the "Histoire de l'Académie Royale des Sciences avec les Mémoires de Mathématique et de Physique", vols. 1700–1730, lacking the volume for 1728, but containing the rare supplementary volume for 1718, and Robert Boyle's "Paradoxa Hydrostatica" (1670).

LETTERS TO THE EDITORS

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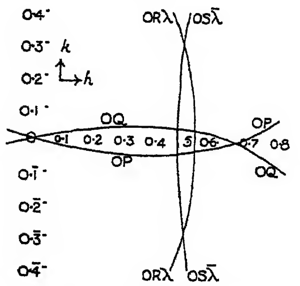
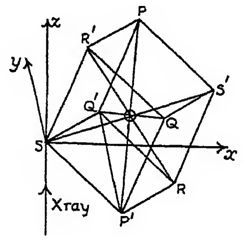
Diffuse Spots in X-Ray Photographs

IN a recent letter[1] Mrs. Lonsdale reports that the shapes of certain "diffuse spots" in the pattern due to mono-chromatic X-rays which have been scattered by sodium are in agreement with calculations made by Jahn, and points out that this is the more noteworthy because the calculations had to take into account the peculiar anisotropy of the elastic constants of sodium.

I have previously observed that simple diffraction formulæ provide an accurate position of the positions of the spots, and also of many of the peculiar forms which they assume[2]. These formulæ are independent of the elastic constants.

For example, one of the photographs attached to Mrs. Lonsdale's letter shows a four-square spot. The sodium cell is body centred. The four conditions that the centre of the cell shall be in phase (by means of integral differences of wave-length) with the corners can be stated in the form of equations, which describe the relations between the direction cosines of the diffracted ray. Four of these curves are found to intersect in four points close together (see the accompanying figure), and the positions of these points agree within experimental error with those of the corners of the four-square spot in the photograph. It follows that at each of these four points, the centre of the cell is in phase with two of the corners and very nearly in phase with the other two. The combination is strong, and the peculiar diffused spot may be supposed to be its consequence.





The figure on the right represents the body-centred cubic sodium cell. The points $SRS'R'$ are in the plane of the paper: PQ and $P'Q'$ are perpendicular to it, and so is the y axis to which they are parallel. The X-rays are parallel to the axis of z. The angle between SR' and the axis of z is $20·5°$. The figure on the left shows the (hk) curves. For example, OP is the locus of those values of (hk) which the diffracted ray must have if the path by way of O is of the same length as that by way of P: along $OR\lambda$, the path by O differs by one wave-length from that by way of R.

The simple diffraction formulæ have so far predicted accurately all the positions of the diffuse spots, except that in a few cases spots are absent that might have been present according to calculation. If I apply the theory which ascribes the spots to the interaction of the structural periodicities of the crystal and the periodicities of elastic waves, I am not equally successful. It may be that I misunderstand the theory, which I would describe in the following way:

To take a simple case, let a wave be travelling along one of the principal axes of a simple cubic cell (such as that of potassium chloride). The velocity of the X-rays is so great in comparison with that of the elastic wave that the latter may be taken to be at rest while it is under consideration. The full period along the axis is now the least common integral multiple of the two wave-lengths. A super-lattice comes into existence. Waves of various lengths running in all directions provide an infinite number of these super-lattices, all of them integral multiples of the cell lattices.

When monochromatic rays fall on a perfect crystal there are no reflections. Laue photographs are blank. But when these conditions are only realized approximately (the possibility of the number of scattering centres being small is excluded from the theory under consideration) there may be accidental reflections. The multiplicity of super-lattices provides increased opportunities, and the diffuse spots are supposed to be the consequence.

One method of calculating results in a simple if approximate way is to assume only the one crystal cell, and to allow planes to have at least one fractional index. In every zone one such plane can be found to be a reflecting plane in the circumstances of the experiment. If the axes of the zones lie in the cubic face of the crystal on which the incident rays are striking almost normally as in the case described in NATURE[3], the calculated result is a network which agrees closely with observation for points near the origin but is seriously wrong farther out. If other zone axes are chosen, and there seems to be no reason for limiting them in the above way, indications are given which do not agree with observation.

It would be a strong support to the elastic wave theory if the calculations could correct this interpretation and show an agreement with the case quoted in the communication in NATURE to which I have referred.

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Nov. 28.

[1] NATURE, 148, 628 (1941).
[2] Proc. Roy. Soc., 179, 51, 94 (1940).
[3] NATURE, 146, 509 (1940); Proc. Roy. Soc., A, 179, 54 (1940).

Influence of Temperature on Gel Formation

IT has been pointed out[1] that in the sol-gel change, gel formation should be more rapid the higher the temperature, in the absence of changes of solubility with temperature.

In the case of pectin-sugar gels, the method of preparation is generally such that the temperature of the mix is dropping while setting takes place, so that the dependence of setting rate on temperature is complicated. It is well-known, however, that jellies can be prepared by mixing a pectin-sugar solution not sufficiently acid for gel formation, with an acid solution; the mixture can then be maintained at a constant temperature during the setting period. Sucharipa[2] states that with mixtures of this type, setting is more rapid as the temperature is lowered: on the other hand, in a recipe booklet[3] for the use of these mixtures, it is stated that setting may be slower in cold weather.

It has been found in a series of experiments on jellies prepared from apple pectin, and containing 50 per cent sugar, that, over at least a limited temperature range, setting is much more rapid at the higher temperatures. The same effect was found, though to a less marked extent, with jellies containing 60 per cent sugar.

Two samples of apple pectin were used: *Pectin A*. Alcohol precipitated from commercial apple pectin. 80 per cent of total carboxyl groups esterified. Equivalent wt. = 1,110. *Pectin B*. Prepared by treating commercial apple pectin with sodium hydroxide in the cold, then acidifying and precipitating with alcohol. 67 per cent of total carboxyl groups esterified. Equivalent wt. = 630.

Jellies were acidified with citric acid or citric acid-potassium citrate mixtures: in all cases citrate was 0·8 per cent (as citric acid) in final mixture. *p*H measurements made on 50 per cent solution of jelly. The following are some typical results:

No.	Pectin (% as calcium pectate)	Per cent solids (refractometer)	*p*H	Time for first signs of setting			
				6° C.	13° C.	30° C.	50° C.
1	A, 0·35	52	2·80	15 days	Between 9 and 24 hours	100 min.	60 min.
2	,,	52	3·05	Not set 22 days	Not set 22 days	33 hr.	48 hr.
3	,,	62	3·38	3 days	55 min.	30 min.	20 min.
4	,,	62	3·70	Not set 12 days	5 days	3 days	4 days
5	B, 0·36	52	2·44	6 hr.	50 min.	70 min.	4 days
6	,,	52	2·80	Not set 10 days	Between 6 and 20 hr. (at 20°C.)	Between 6 and 20 hr.	Not set 10 days
7	,,	62	3·20	Several hours	7 min.	2 min.	7 min.

In all cases, mixtures which had failed to set at one temperature, set when the temperature was altered to that found to give most rapid setting. In all cases except series (6), the sugar-pectin solution was kept for several hours before mixing at the final temperature: the series (6) jellies were prepared by boiling, and then transferring portions of the mixture to tubes for storage at the temperatures given.

Of particular interest is the marked difference in the effect of temperature on mixtures made with the two pectin samples. This is in agreement with the more recent work on the effect of methoxyl content of pectin on jelly setting[4] and particularly with American work[5] on the relation between combining weight of the pectin and setting time (in a mixture which is cooling).

It is hoped to continue these experiments over a wider range of conditions: at present, it appears that the time for setting to commence is a minimum at a tmeperature dependent on the composition of the mixture, involving at least the composition of the pectin, the total solids present, and the *p*H.

I have to thank Messrs. H. P. Bulmer and Co., Ltd., for permission to publish this note.

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Hereford.

Dec. 4.

[1] Lawrence, *Ann. Rep. Chem. Soc.*, **37**, 118 (1940).
[2] Sucharipa, "Die Pektinstoffe", p. 304 (1937).
[3] Issued by "Pomosin".
[4] Hinton, "Fruit Pectin", 61–68 (H.M.S.O.).
[5] Olsen, Stuewer, Fehlberg and Beach, *Ind. Eng. Chem.*, **31**, 1015 (1939).

Nomenclature of Fowl Genetics

The nomenclature of fowl genetics has become somewhat confused in recent years. So many characters have been investigated that the difficulty of designating symbols for the corresponding genes has increased considerably. There have been much overlapping and repetition, and the same symbol now frequently represents two, or even three genes. To experimental poultry breeders, and to students attempting to keep in touch with the latest developments, this position gives rise to much confusion.

The accompanying table gives a few symbols chosen at random, which have been used to represent more than one gene, and will serve to illustrate the difficulties:

Gene	Character	Quoted by[1]
F	Feathering	Munroe (1938)
F	Frizzled plumage	Jull (1940)
H	Hatchability	Hays (1924)
H	Henny feathering	Punnett (1937)
A	Broodiness (1)	Goodale *et al.* (1920)
A	Egg size (1)	Hays (1929)
A	Pigment	Numerous
C	Chromogen	Quin (1936)
C	Broodiness (2)	Goodale *et al.* (1920)
C	Egg Size (2)	Hays (1929)
P	Mesodermal Pigment	Bateson and Punnett (1911)
P	Pea comb	Numerous
P	Production persistency	Hays (1927).

I am drawing up a complete summary of known nomenclature; but it is evident from the accompany ing list that the system is in need of standardization. The use of symbols such as P^1, P^2, P^3, etc., is to be recommended, as it avoids the confusion which arises from the practice of some authors of using small letters appended to the symbol. Thus, the gene for light iris is given as *Br*, which is ambiguous, for it could equally well be interpreted as a combination of a dominant gene *B*, and a recessive *r*. This introduces unnecessary difficulties, especially if a long genotype is being dealt with; for example, *AABbFFBBCcLlRRPPccGGHHMmNNEeEEBrbrPp SSWwDD* would allow of numerous interpretations, instead of being at once a self-evident description of the bird's genotype.

The present system leaves much to be desired, and any hope of reaching an understanding of fowl genetics will only be possible when some definite standard of nomenclature is introduced.

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[1] For references see Jull, M. A., "Poultry Breeding" (1940).

Isolation of a New Alkaloid from Perennial Ryegrass

INDEPENDENT investigations in our respective laboratories have resulted in the isolation from perennial ryegrass (*Lolium perenne* L.) of a new constituent with unusual optical properties. Further study has shown that the material is an alkaloid of empirical formula (hydrochloride) $C_{36}H_{22}O_3N_4(OCH_3)_4.2HCl$. It yields precipitates with all the usual alkaloidal reagents and is soluble in alcohol and chloroform, slightly soluble in acetone, ether and water. Dilute solutions of the base in chloroform are golden yellow, with a green fluorescence which can be detected in ordinary daylight at concentrations of 1 in 5×10^6. The alkaloid is reduced by titanous chloride to a colourless material which can be quantitatively reoxidized by ferricyanide. The name perloline is proposed for this fluorescent alkaloid.

Some 40 gm. of perloline have been prepared in our two laboratories in the course of the past growing season, using the usual methods for chloroform- and alcohol-soluble alkaloids. The key to large-scale preparation lies in growing grass with sufficiently high alkaloid content, and this problem has not been completely solved.

The observed variation in concentration is high, ranging from a trace (about 3 μgm. per gram dry matter) to 1 mgm. per gram. The conditions governing high alkaloid content are obscure, but in general the highest concentrations have been noted at times corresponding with rapid growth.

A simple and rapid method of assay has been devised, depending on the colour of solutions of the base in chloroform. It requires only 2 gm. dry material.

In addition to perloline, several other alkaloids have been found in ryegrass, but data concerning them is at present indefinite.

A full account of the investigations on the preparation, characterization and pharmacology of perloline will appear in the *N.Z. Journal of Science and Technology*.

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Determination of Death in the Larvæ of the Potato Root Eelworm

ONE of the major difficulties in the work of helminthologists has been to differentiate between living and dead nematodes. According to Lapage[1], most of those who have studied the metabolism of these worms have taken their failure to move either as a result of or without the action of a stimulus as an indication that they are not alive.

This difficulty has again arisen in the course of work by me on the biology and control of *Heterodera schachtii*, the eelworm which attacks potato roots and causes a serious diminution in crop in many districts.

First-stage larvæ are liberated by the action of potato root excretion on the cysts of the eelworm which are found in the soil of an infested field. These larvæ then penetrate the potato rootlets with the ultimate formation of new cysts which remain in the soil and thus increase the infestation. In the laboratory the larvæ can easily be obtained in quantity by immersing cysts in potato root excretion.

Normally under suitable conditions most of these larvæ are in active motion, but it frequently happens that they lie quite still for a relatively long period and then, for some undiscovered reason, recommence active movement. They may also show no sign of movement when observed in watch-glasses, but yet be able to penetrate potato rootlets. Thus it is exceedingly difficult to distinguish whether larvæ are in a state of dormancy or whether they are dead. According to Baunacke[2] who made a study of the beet strain of this eelworm, that part of the larval body near the oral end, which is almost completely hyaline in the living larva, becomes granular after death occurs. This tends to impart a uniform opacity to the dead larva. After treatment with certain solutions or after exposure to certain degrees of heat, larvæ of the potato strain of *H. schachtii* have been observed to be in a condition similar to that ascribed by Baunacke to a dead larva. Other larvæ have been seen to show a peculiar distension of the body wall near the higher end of the intestine, while this organ itself had become displaced.

Though it is known that living nematodes may in certain cases have the appearance of being dead, it has been ascertained that larvæ of the potato strain of *H. schachtii* in the above-described conditions could not be induced to form cysts on the roots of potato plants. Such larvæ were considered to be dead.

It was also determined that dead larvæ of both these types could be more clearly distinguished from living larvæ by staining with a solution of 0·025 gm. iodine in 100 c.c. 1 per cent potassium iodide solution. The most satisfactory procedure was to use five drops of this solution in 2 c.c. of a larval suspension. The suspensions employed contained some larvæ in active motion and some considered to be dead. The latter absorbed the iodine and were stained within a few minutes, being best observed after 10–20 minutes. Those larvæ which were moving and thus known to be alive originally became motionless after a few minutes but yet retained the appearance of living larvæ for several hours and did not absorb the stain. They were killed, however, when left in the solution overnight.

The iodine penetrates the dead larvæ through the mouth, and by careful observation a yellowish coloration may be seen starting at this end and gradually permeating the whole body.

Larvæ which exhibit a slight granularity in the upper region of the body, that is, larvæ which according to Baunacke's criterion are newly dead, do not take up the iodine immediately. They do stain, however, after being allowed to stand for 24–48 hours before applying the solution. Work along this line is being conducted in connexion with the thermal death point of the larvæ.

First-stage larvæ which had been kept in potato root excretion solutions for several weeks, and which by using up all their reserve food material had become practically colourless and clear except for a small granular portion near the mouth, absorbed iodine only slightly in this region while the rest of the body remained almost unstained. This is apparently due to the absence of intestinal contents in larvæ which had been in a free state for several weeks.

Hence larvæ of the potato strain of *H. schachtii* which appear granular in that part of the body which in the living larvæ is hyaline also show an internal absorption of iodine and may be considered as dead. The two main disadvantages of the staining process are that the iodine itself eventually has a toxic effect and that the staining does not take place immediately after death.

This work has been conducted during the tenure of a Carnegie Research Scholarship.

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[1] Lapage, G., "Nematodes Parasitic in Animals" (London, 1937).
[2] Baunacke, W., Untersuchungen zur Biologie und Bekämpfung des Rübennematoden (*Heterodera schachtii*, Schmidt). *Arb. Biol. Reichamst. Land. u. Forstw.*, XI (1922).

Sheets of Pure Epidermal Epithelium from Human Skin

THE margin between dermis and epidermis is one natural-splitting layer of human skin. By the gentle tryptic digestion of flat human skin slices for a length of time depending on their thickness, it is possible to disengage the epidermis in the form of an intact sheet uncontaminated by mesodermal elements. There is histological[1] and clinical[2] evidence that the *elastic fibres* of the so-called 'basement membrane' play an important part in anchoring the epidermis to the underlying tissue. Elastic fibres are known to be rapidly and specifically dissolved by trypsin.

The skin-slice should be the thinnest possible razor cut, the Ollier-Thiersch graft of plastic surgery. In theory, the Thiersch graft cuts through the base of the projections of the Malpighian layer into the dermis and therefore contains only so much of the dermis as lies between them. Studying expertly cut grafts I have found that even when the slice is so thin as to be transparent, it is lined on the inside by a sheet of dermis which is interrupted only by the holes into which the hair-follicles fit. Paper-thin shavings of rabbit, rat or dog skin may be used in place of human skin; but the excessive number of hair follicles makes the splitting reaction less clear cut.

The digestion fluid I use is a Seitz-filtered 0·5 per cent solution of B.D.H. trypsin powder in Tyrode's solution containing 1 : 100,000 phenol red and adjusted by means of it to pH 7·8–8·0. Digestion takes place at 37° C. Under these conditions, 1 ml. of the digestion fluid clots 5 ml. of calcified milk in 90–110 seconds. For *thin* slices, an hour's digestion is quite sufficient. The epidermis disengages of its own accord in the middle of the slice and can be lifted off or cut away with fine forceps and scissors.

Tissue-culture studies on the reagent described above show that at least some cells in isolated fragments of the chick-embryo's heart survive tryptic digestion even after a treatment lasting eighteen hours. There is this and other evidence that the epidermal sheet remains 'alive'. On the other hand, emulsions of isolated skin cells and epithelial islands, prepared by prolonging digestion until the Malpighian layer undergoes erosion and maceration, or, better, by simply scraping the epidermal sheet under Tyrode's solution, are probably irretrievably damaged, although they make excellent histological smear preparations. This is because the cells of the 'prickle-cell' layer are united to one another by fine cytoplasmic processes, and destroying one cell—for example, by pricking—initiates a reaction of nuclear coagulation which is propagated at least to immediately neighbouring cells[3].

This work has been reported at a technical stage in the hope that epithelial sheets will be useful to workers studying specific cellular metabolism, diffusion and so forth. Thiersch grafts cannot be cut exactly to the size of the recipient area, so that left-over pieces of skin are usually available in the theatre. They may be stored for a day or two at 4° C. after laying them raw side downwards on squares of gauze moistened with Ringer's solution.

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[1] Pautrier, L. M., and Woringer, F., *Ann. de Dermat. et Syph.*, 1, 985 (1930); Szodoray, L., *Arch. Derm. Syph.*, 23, 920 (1931). The second paper reviews the histological evidence.
[2] Clinical and other evidence is discussed by Sutton, R. L., and Sutton, R. L., "Diseases of the Skin", London, 1939, pp. 5–6, 562–7.
[3] Chambers, R. W., and de Rényi, G. S., *Amer. J. Anat.*, 35, 385 (1935).

The Relations between Science and Ethics

To the interesting discussion aroused by Dr. C. H. Waddington in NATURE[1] may be added comments reflecting United States opinion on the matter.

It was remarkable that three leading American biologists, representing the east, mid-continent, and west, should have come to about the same conclusion at the same time regarding a biological basis for ethics. Different approaches led to the same general position on the part of Prof. E. G. Conklin, emeritus professor of biology at Princeton University, Prof. C. Judson Herrick, emeritus professor of neurology at the University of Chicago, and Prof. Samuel J. Holmes, professor of zoology at the University of California. Conklin[2] says, "Biologically life is maintained by continual balance, co-operation, compromise, and the same principles apply to the life of society. The highest level of human development is attained when purpose and freedom, joined to social emotions, training and habits, shape behaviour not only for personal but also for social satisfactions. Conduct bringing the broader and more lasting satisfactions is the better." According to Herrick[3], "That social stability upon which the survival and comfort of the individual depend and that moral satisfaction upon which his equanimity, pose and stability of character depend arise from the maintenance of relations with his fellow men which are mutually advantageous." Holmes[4] says, "Morality becomes just one phase of the adjustment of the organism to its conditions of existence. As a good body is one which runs smoothly and efficiently in the maintenance of its vital functions, so a good man is one whose conduct not only maintains his own life on an efficient plane, but conduces to the enhancement of the life of his social group." Both Conklin and Herrick would agree with Holmes in saying, "Peoples may believe that their moral customs derive from a supernatural source, but one potent reason for their adoption is their conduciveness to survival."

These statements suggest that American biologists have come to the same position as Dr. Waddington in regard to the nature of science's contribution to ethics, that is, in revealing the character and direction of evolution with the elucidation of the consequences "in relation to that direction, of various courses of human action". Our British colleagues may recall

Conklin's volume, "The Direction of Human Evolution", which was published in 1921, and which offers much detailed evidence in support of Dr. Waddington's position.

At the 1940 Christmas meeting of the American Association for the Advancement of Science in Philadelphia, the Section on Historical and Philological Sciences held a symposium on "Science and Ethics". Participating in this symposium, over which I had the honour of presiding, were Profs. Herrick, Conklin, Holmes, Teggart, Mackay, Galdston, de Santillana, Sigerist, Sarton, Shryock, Gerard, Birkhoff, and Mayer. At the conclusion of the discussion, the section unanimously agreed to a descriptive statement which seems justifiably inducible from data now available. While taking into account criticisms of the intellectual validity of traditional ethical statements as raised by psychology, anthropology, dialectic materialism, or logical positivism, the statement of these American men of science indicates that they are willing to agree, at our present "level of analysis" as Dr. C. H. Darlington[5] might put it, that certain biological generalities have moral consequences. The recognition by conscious individuals of these consequences, results in "ethical principles as actual psychological compulsions derived from the experience of the nature of society."

The statement may be put in a formal manner: The probability of survival of a relationship between individual humans, or between groups of humans, increases with the extent to which the relationship is mutually satisfying and advantageous. This principle was first formulated in this manner at a memorable seminar in the Santa Cruz redwoods in July, 1939, when the Pharmacology Laboratory of the University of California entertained Profs. Conklin, Herrick, and Olof Larsell.[6] It was then appreciated that this formulation is merely a special case of the more general biological principle: The probability of survival of individual, groups, or species of living things increases with the degree with which they can and do adjust themselves harmoniously to each other and to their environment.

The ethical significance of this general principle appears in relation to the common biological urges for survival and satisfaction. Consciousness of the operation of this generality suggests the wisdom of such altruistic, considerate, and magnanimous conduct as is intuitively considered 'good' in all ethical systems. The social customs and conventions now with us have so far exhibited survival value in a Darwinian sense. We may apply evolutionary criteria to them and attempt the formulation of a *modus operandi*. Such a formulation constitutes the statement. The principle operates, whether we as humans are conscious of it or not. To promote the conscious appreciation of such natural principles is part of the business of science. There appears to be scientific justification for what philosophers have maintained for centuries, namely, that knowledge of ourselves and of our environment has in itself ethical significance and moral consequence.

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November 22.

[1] NATURE, 148, 270 (1941).
[2] *Scientific Monthly*, 49, 295 (1939).
[3] *Scientific Monthly*, 49, 99 (1939).
[4] *Science*, 90, 117 (1939).
[5] NATURE, 148, 344 (1941).
[6] *Scientific Monthly*, 53, 133 (1941).

Mathematical Theory of Population Movement

AMONG the obvious motives of mankind are the tendencies to seek company and to seek living-space. If we were to regard these tendencies as being in simple opposition to one another, we should expect the population to be able to remain uniformly spread over any uniform piece of land; and the familiar contrast between town and country would then appear, to the theoretical mind, as a mystery requiring explanation. We may, however, seek a hint as to why people concentrate into towns from Sir James Jeans's theory of why matter concentrates into stars[1]. For his theory is also concerned with two opposing tendencies: to draw together by mutual gravitation and to spread out by pressure.

Let ρ denote the density of the astronomical matter, supposed initially uniform, let $s = \delta\rho/\rho$ be its concentration at any time t and place, let p be its pressure and γ the constant of gravitation. Then Jeans showed that deviations from uniformity occur in accordance with the equation

$$\frac{d^2 s}{dt^2} = 4\pi\gamma\rho s + \nabla^2\left(s\frac{dp}{d\rho}\right). \qquad (1)$$

The essence of Jeans's theory is that the opposition between gravitation and pressure is not simple: the former is represented by a term in s, the latter by a term in $\nabla^2 s$. These considerations led me to inquire whether the existence of towns could be explained by

$$\frac{ds}{dt} = \gamma\rho s + \left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\left(s\frac{dp}{d\rho}\right). \qquad (2)$$

in which ρ, supposed initially uniform, is the number of persons per square kilometre, $s = \delta\rho/\rho$ as before, x and y are horizontal co-ordinates on a flat portion of the earth, γ is a constant expressing gregarious attraction, and p is called pressure of population. The social equation (2) has been made of viscous type by replacement of the astronomical d^2s/dt^2 by ds/dt.

Whereas Jeans began the astronomical theory with γ known and p clearly understood, and thence deduced the spacing of the stars, we have to begin the social theory at the other end, and work backwards to find out more clearly what γ and p mean. Equation (2), in which $dp/d\rho$ is an unknown constant, explains why the population does not remain uniformly spread. For the amplitude of a standing wave of s either grows or diminishes, according as the wave-length is greater or less than a critical length. It can be deduced that $dp/\gamma d\rho$ is of the order of magnitude of the ratio of the number of persons in a country to the number of towns in it. Further, $dp/d\rho$ is seen to play the part of a diffusivity in equation (2). From the observed time of dispersal of concentrations having diameters much less than the distance between towns, it can be estimated that $dp/d\rho$ is of the order of 10^5 cm.^{2} sec^{-1}. Whence it follows that γ is of the order of 10 or 10^2 cm.^{2} sec.$^{-1}$ person^{-1} for normal people.

A fuller account is ready for publication as part of a book.

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[1] Jeans, Sir James, "Astronomy and Cosmogony" (Camb. Univ. Press, 1929).

RESEARCH ITEMS

Production of Cancer by Ultra-violet Irradiation

THIS topic was discussed by H. P. Rusch and B. E. Kline at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The idea that sunlight is an important causal agent in cancer of the skin is not new. The high incidence of skin cancer in sailors has long been known, and nearly fifty years ago 'seaman's skin' was described as a precancerous condition attributable to continued exposure to light. However, only in the last decade has experimental support been formed for the theory of direct causation of cancer by sunlight. The authors have determined the wave-lengths of the spectrum responsible for cancer production and measured the amount of energy required for the process. White mice were used in these studies. The wave-lengths responsible were found to lie between 2,900 A. and 3,341 A. The minimum time for the development of tumours was about two and a half months, and it was not necessary to irradiate the animals throughout the precancerous period. Once initiated, carcinogenesis proceeded without further exposure, and sometimes several months elapsed between the end of irradiation and the appearance of tumours. Very little radiant energy was needed to initiate those changes which culminate in tumour formation. The tumours produced were true malignant cancers of the same type found in humans.

Controlling the Micropopulation of the Soil

IN a paper read at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15, C. Thom of the U.S. Bureau of Plant Industry reviewed experimental work towards control or direction of the microbial activities of the soil to produce desired ends. The destruction of waste plant and animal matter by soil micro-organisms is the function of the soil micropopulation most commonly understood. Variations from comparatively small totals to fabulous numbers of soil organisms were recorded. There arises the possibility of controlling this capacity of the normal groups represented in the population to multiply with great rapidity, in such a manner as to produce great decomposing power at selected times and for our purposes. For example, such activity may either rob a root parasite of available nutrients or actually destroy the parasite. Application of the principles developed in the control of take-all of wheat and cotton root rot were discussed.

Gardeners and the Moon

MANY practical gardeners insist that some plants grow best from seeds sown at a particular phase of the moon. K. Mather and J. Newell have obtained some experimental evidence on this question (*J. Roy. Hort. Soc.*, **66**, Pt. 10, Oct., 1941). There is apparently no consistent lunar effect upon germination; but it is unfortunate that the authors do not appear to trust their results in one experiment where a marked effect of the April full moon was demonstrated. The work requires to be repeated many times, with full measurements of lunar radiation and of other climatic factors, for the problem is one involving the microclimate round a plant—it is far more than the investigation of an astrologically inspired opinion.

Fungus Diseases of the Carrot

THE tenth part of a series of articles by D. E. Green on "Hygiene in the War-time Vegetable Garden" (*J. Roy. Hort. Soc.*, **66**, Pt. 11, Nov., 1941) contains a short reference to several diseases of carrots, information about which is not readily available. Black rot, *Alternaria radicina*, violet root rot, *Helicobasidium purpureum*, storage rot, *Sclerotinia sclerotiorum*, and soft rot, *Bacterium carotovorum*, are briefly described.

Vitamin C and Respiration

IN 1933, Harrison, in exploring the possible connexion between tissue respiration and *l*-ascorbic acid, found that addition of the vitamin to liver tissues of scorbutic animals increases their *in vitro* oxygen uptake. G. A. Snow and S. S. Zilva (*Biochem. J.*, **35**, 783, 787; 1941), in studying this phenomenon in greater detail, now find that the respiration of liver slices from guinea-pigs maintained on a quantitatively restricted diet (containing, however, ample vitamin C) is indeed considerably increased by the addition of ascorbic acid. Furthermore, the stimulating action on the respiration is not confined to ascorbic acid alone, but can be brought about by the presence of chemically related compounds, such as *d*-glucoascorbic acid and reductic acid, which possess a similar reduction potential but no ascorbic activity. The inhibition by phloridzin and pyrophosphate and the failure of cyanide, iodoacetate and malonate to inhibit the above accelerated respiration produced by ascorbate on the liver tissue of underfed animals indicates that this increased respiration may be connected with any of the stages concerned in the anærobic formation of triosophosphate from glycogen or in the aerobic degradation of the intermediate products, but not with the compounds formed by the anaerobic breakdown of triosophosphate.

Seismic Activity since 1904

SEISMIC activity in the twentieth century has recently been discussed by B. Gutenberg and C. F. Richter ("Seismicity of the Earth", by Beno Gutenberg and C. F. Richter, Geological Society of America, Special Paper No. 34, August 30, 1941). The data are chiefly instrumental concerning shallow shocks, though some new data on deep focus shocks are included. 54 great shocks during 1904–39 have been given revised epicentres, all large shocks from 1926 until 1933 are listed, and many other epicentres are given. Much of the data comes from the International Seismological Summary. The authors suggest that the earth's surface consists of relatively inactive blocks separated by active zones of three groups: (1) the circum-Pacific zone, which contains many shallow shocks, many intermediate depth shocks, and all the very deep shocks; (2) the Mediterranean and trans-Asiatic zone; (3) narrow belts of shallow shocks which extend (*a*) through the Arctic and Atlantic Oceans, following the mid-Atlantic ridge, (*b*) through the western Indian Ocean from Arabia into the Antarctic, (*c*) the African rift valleys. Gutenberg and Richter suggest that the annual average includes about one great shock, about a hundred potentially destructive shocks, and about one million shocks potentially strong enough to be felt in a settled area. Seismic energy is released at a mean rate of about 10^7 kilowatts, most of it in

the large shocks. It is possible that the persistence of oceanic troughs and gravity anomalies, together with the occurrence of earthquakes, requires that in the regions affected there is a continuously operating mechanism, such as would be provided by constant subcrustal flow.

Hydrocarbon Flames in Atomic Oxygen

A RE-EXAMINATION by K. H. Geib and W. M. Vaidya (*Proc. Roy. Soc.*, A, 178, 351; 1941) of the flames of hydrocarbons burning in atomic oxygen shows that the ethylene bonds are strong in benzene and acetylene, but are weak and diffuse in ethylene. C_2, CH and HO are also present. Methyl alcohol gives the HO and CH bonds and also 'cool flame' bonds rather faintly, while formaldehyde shows only the HO bond at λ3064. The ethylene flame bonds are absent from the flame of benzene burning in atomic hydrogen, which yields only C_2 and CH bonds. The Balmer lines also appear, however, due to stray light from the main discharge.

Fission Yield by Fast Neutrons

THE 1,100-kv. tube of the Instituto di Sanità Pubblica at Rome was used by a group of workers, M. Ageno, E. Amaldi, D. Bocciarelli, B. N. Cacciapuoti and G. C. Trabacchi, for measurements of the fission cross-section of uranium for neutrons produced in the reactions Rn + Be, D + C, D + D, D + Be, D + B and D + Li (*Phys. Rev.*, 60, 67; 1941). From the fact that the mean cross-section has about the same value for neutrons of the D + D, D + Be, D + B reactions, it was concluded that the fission cross-section has a value σ_f which remains nearly constant between 1 and 10 Mev. For neutrons of the Rn + Be and D + C reactions the fission cross-sections seem to be, respectively, about $\frac{1}{2}\sigma_f$ and $\frac{1}{3}\sigma_f$. Finally, for neutrons of the D + Li reaction the mean cross-section is $1 \cdot 4\,\sigma_f$. This fact was interpreted by N. Bohr as due to successive transformations which are possible for energies of the impinging neutrons larger than 10 Mev. A similar increase of the fission cross-section was observed also for thorium, in very good agreement with the theoretical predictions of Bohr.

The Mills-Nixon Effect

THE bond angles in a molecule containing a saturated 5- or 6-membered ring fused to a benzene ring cannot have the normal values in the aliphatic and aromatic portions. W. H. Mills and I. G. Nixon, in 1930, inferred from substitution experiments that the double bonds in hydrindene and tetralin are frozen to the particular Kekulé structure in which the bond angles are the least strained. This conclusion is somewhat modified in detail by taking account of excited ionic resonance states of the benzene molecule, and in 1935 L. E. Sutton and L. Pauling published an approximate quantum mechanical treatment which showed that theory predicts a relatively small stabilization of one Kekulé structure in hydrindene and in tetralin. An investigation of 1,3,5-tribromobenzene, *o*-dibromoxylene, *o*-dibromohydrindene and *o*-dibromotetralin by the electron diffraction method, made by A. Kossiakoff and H. D. Springall (*J. Amer. Chem. Soc.*, 63, 2223; 1941) has given some interesting results. It is shown that the complete fixation of the double bonds in the hydrindene or the tetralin compound is excluded, that there is a large amount of double-bond character for the C–Br bond in the bromobenzenes, particularly in the hydrindene derivatives, which throws light on the relative importance of the excited ionic states, and that the effect of strain on the benzene molecule (Mills-Nixon effect) is primarily concerned with changes in the contributions of excited states of the molecule rather than with fixation of double bonds into a particular Kekulé structure. In agreement with Sutton and Pauling's calculations, the change in external bond angles of the benzene ring caused by the fusion of a saturated ring is shown to be very small.

Space Motions of Solar Prominences

THE first exhaustive study of the structure of solar prominences in the three space co-ordinates x, y, z is reported from the McMath-Hulbert Observatory (*Pub. Obs. Univ. Michigan*, 8, 123; 1941). From nearly 2,000 $H\alpha$ spectroheliograms of a prominence on September 20, 1940, taken on motion-picture film with two spectroheliographs (one for cross-motions and one for radial velocities), the parameters x, y, dz/dt, and t are measured for four easily identified prominence knots. For each knot a process of graphical integration then gives the true space motion as a function of t. The only difficulty, that of arriving at z from dz/dt, is ingeniously solved by making an approximate estimate of the constant of integration from subsequent observations of the prominence as a dark marking projected on the disk. From the data thus derived, a model of the prominence has been constructed; and photographs of this model taken from various angles show a close resemblance to frequently observed prominence forms. The accelerations derived from the observed displacements and velocities are of the order of one tenth that due to unopposed gravitation at the solar surface, though for short intervals of time accelerations exceeding the gravitational value have been observed. The radial and cross velocities are of the same order, as would be expected if the observed effects are due to mass motion of the prominence atoms, as distinct from a travelling excitation.

Dimensions and Masses of Wolf-Rayet Stars

CECILIA H. PAYNE-GAPOSCHKIN (*Telescope*, May–June) has discussed the star *H.D.* 193576, known to be a spectroscopic binary, and recently found by Dr. S. Gaposchkin at Harvard to be also an eclipsing binary. A considerable amount of speculation had been made about the size and mass of a Wolf-Rayet star; but now, assuming that *H.D.* 193576 is representative of this type, a volume six times and a mass ten times those of the sun can be taken as approximately correct. The bright-line spectra of these stars reveal the presence of highly ionized atoms of the commoner elements, notably helium, carbon, nitrogen and oxygen. The width of these bright lines led to the conjecture of nebular stars of enormous size, because the novæ, which have many points of resemblance to Wolf-Rayet stars, expand to vast dimensions. On the other hand, the displacement from the normal wave-length of these bright lines led to the picture of small, dense stars, the shift arising from the intense gravitational potential. Now that the size and mass are known, both the width and displacement of the lines appear in a new light. It is suggested that the red shift of the bright lines (a phenomenon occurring also in 29 Canis Majoris) is caused by washed-out absorption lines on the violet edges of the bright lines. The gravitational red-shift in a star of size and mass like those just given for a Wolf-Rayet star would be only about one hundredth of what has been observed.

HUMAN BIOLOGY IN EDUCATION*

UNTIL comparatively recently biology might well be said to have been the 'Cinderella' of the sciences so far as primary and secondary education in Great Britain were concerned. Over a period of about ten years, however, the subject has become recognized more and more as of vast cultural and academic importance. Consequently it is finding its place in many schools where it was hitherto completely ignored and in all cases the number of students studying biology has increased. This is well exemplified in the number which take the subject in the School Certificate, though even to this day the percentage is far too low. During 1940 in the School Certificate 22 per cent took biology and 19 per cent General Science; in the Higher School Certificate only 7 per cent took biology.

We are, however, not concerned so much with the importance of biology as an educative subject but rather with the form and content of the biological syllabuses from junior school to university. The syllabuses are unsatisfactory from several points of view but the most important is that of man himself. In most syllabuses he scarcely finds a place. One reason for this might easily be that many academic biologists do not realize that biology is the science of life and not merely a union of zoology with botany. Human biology is the science of life as it affects man himself and it thus finds itself invoking aid not only from zoology and botany but also from the other specialized biological sciences such as medicine, agriculture, anthropology, ethnology and sociology. Human biology consists of a comparative account of the anatomy and physiology of the human body followed by further inquiries into man's place in the web of life, the nature of diseases, especially as they affect mankind, inheritance, and so forth. These are certainly essential components of human biology but the potentialities and applications of this tremendous subject are legion. Surely the study of the biology of mankind must not merely be regarded as a detached and academic survey of structure and function. It must go further and launch bravely into investigations of all these powerful individual social relations which are biological in origin. The question of the results of both good and bad nutrition is involved. The same can be said for population movements and their attendant effects, not excluding war. Soil and its significance is another aspect. So is the influence of psychological study as a powerful weapon in the hands of thinking and feeling man. Human biology is therefore the biology of mankind, not merely the biology of man.

Knowledge of the general principles of positive health is essential in these modern times of urban living, yet it receives scant attention in most biology courses. Aspects of healthy living such as fresh air, housing, exercise, personal cleanliness, human parasites, risk of infection, industrial diseases, etc., need not necessarily be grouped together under a general heading of health, because pegs on which arguments in this connexion can be based are constantly cropping up in a course of biology so that health subjects could be brought in at various points thus giving, apart from empirical knowledge, what is just as important, additional interest.

The science of nutrition was beginning to take shape long before the War. People were beginning to become vitamin conscious but very often along the wrong channels. There are very few people now who have not heard of vitamins, if only through the medium of a dance tune. It is doubtful, however, if one per cent of the population could give any idea of what a vitamin is or what it does. This should therefore form a subject of instruction and the biology course is the place for it. The history of work on vitamins, from the empirical work in the sixteenth century of the navigator Hawkins and later of Dr. J. Lind to the biochemistry and physiology of to-day, simply told, would be of great educative value. The same applies to nutrition. The sociological and economic implications of nutrition have been brought out very clearly by such workers as Sir John Orr, and their work is receiving the consideration it deserves in the planning of the national health and diet. But this is due to the exigencies of war; it must continue in peace-time, and the basis for its continuance lies in the schools and the universities. A detailed knowledge of the chemical composition of carbohydrates, proteins, fats and mineral salts and vitamins is not necessary, but some knowledge of the significance of these foodstuffs in relation to energy, body-building, malnutrition, deficiency diseases, etc., is desirable.

Technical knowledge which might be considered for inclusion in biological courses especially in the schools involves such subjects as farming and gardening. Schools in rural areas often include these subjects in their curricula though in most cases they are treated as separate subjects. They might well be incorporated in a general biology course, but in spite of this only about one in every ten of the British farmers receives any form of technical training.

Another important subject to whom biological knowledge would prove of inestimable value is the mother in the home. The home with its family life is a veritable biological laboratory. Yet few mothers are technically prepared for the responsibility of directing that laboratory, having little or no knowledge of such subjects as normal psychology, health, hygiene, nutrition, sex, child development and child guidance. Other examples could be given, but here are two—one of man outdoors and one of man indoors—which show what a mistake is this ignorance of the general public where elementary problems of the biology of mankind are concerned.

Human reproduction, too, should be given its logical position in biology curricula. It should not be avoided or ignored; nor again should it be over-emphasized. One is on safe ground in stating that by far the majority of elementary biological curricula, though probably dealing with sexual reproduction in general, and in plants and a certain number of the lower animals in particular, stop at the stage where human reproduction should be logically considered. This is undesirable, but, on the other hand, there is a risk of over-emphasizing it. Human reproduction could be brought into that part of the curricula dealing with heredity in plants and animals. Here reproduction might be combined with considerations of evolution, variation and genetics. Heredity in

*Extract from the opening address by the Chairman, Mr. L. J. F. Brimble, to the Conference of Lecturers and Teachers held under the auspices of the Educational Advisory Board of the British Social Hygiene Council at Ashburne Hall, Manchester, during December 13–14.

man is a very wide subject but general points are valuable even to the child mind. The biological conception of ethnic races, for example, should be emphasized, thus, especially at the present time, counteracting the poisonous results of the prostitution of such concepts for political advantage such as is seen in the Nazi Aryan theory of *Herrenvolk*. A general review of these subjects would develop a social consciousness among children and students towards people of weak hereditary endowments.

A general idea of the origin of man could naturally follow instruction on evolution and heredity. So, too, could the origin of many of man's social attributes which would involve an elementary study of the main conceptions of anthropology, ethnology and archæology. This is scarcely touched upon in schools. A review of the origin and history of mankind would logically lead up to the present status of man in the living world and hence to the destiny of mankind. Modern science is changing the environmental setting of man at an ever-increasing rate. This calls for active and continuous readjustments (adaptation) both physically and psychologically. Here human biology through the study of emotions can arouse a better social conscience since it can formulate new social standards. For example, nutritional deficiency could be eliminated in a measurable time from Europe, as shown by Sir John Orr. It would not take much longer to do the same thing in the British Colonies, as shown on several occasions lately by Lord Hailey, though it can and should be tackled. Eventually nutritional deficiency could be attacked and eliminated from the whole world, as envisaged by Mr. J. G. Winant.

So-called abnormalities in man are now much better understood than they were at one time. They have been in many cases set free from mythical and magical taboo, and are known to be psychological or hormonal. Knowledge of the causes of such abnormalities would bring a more practical and less sentimental sympathy from the general public and especially from those in authority. A more rational view of what is right and what is wrong would surely be the outcome of all this. This aspect of human biology could not be included in courses for children, but should certainly be studied by teachers so that they may be adequately equipped to deal with situations as they arise.

Human biology has given a fresh and more balanced approach to personal evaluation and character training. It would equip the teacher himself with a better insight into the character (normal and abnormal) of his pupils. It would liberate the vexed question of sex from the ignorance, taboos and emotional complexes by which man is hemmed in socially.

Thus it may be said without much fear of contradiction that human biology is lifelong and continuous. Some will go so far as to say that it should displace academic biology (as at present formulated) in education. But even the most moderate will agree that man and mankind ought to receive major consideration in any comprehensive general biology syllabus; yet he does not. Places where human biology might well be introduced are chiefly the teacher training colleges and departments and the junior and senior schools where there is no domination of an external examination syllabus. It is a difficult subject to teach, much more difficult, for example, than higher mathematics, and few teachers are at present mentally equipped to deal with it. In spite of this, however, it should be developed because (*a*) it is far more effective in facts and ideas; (*b*) it is far more interesting; (*c*) it relies less on detailed routine laboratory experiments but leads to demonstrations and experiments on the self, and other interesting activities such as visits to farms, water-works, hospital laboratories and to talks by such social biologists as medical officers of health, nurses, etc.

As expressed in the Autumn issue of *Biology* (7, No. 2), there is a strong case for the study of human biology, in which man himself becomes the centre of interest, seen against the background of all the living matter to which he is related, and of the material world. Human biology grows out of nature study and academic biology, which still dominate our text-books and syllabuses; but it is something of more entrancing interest, at once more personal in its application and of far greater educational worth. For the problems of human biology confront us at every turn: problems of individual and public health, of nutritional standards, housing, population movements, of race and nation; problems of family life, of the relations and responsibilities of one person to another, and of the social policy of the State. Human biology brings up questions of personal conduct, of moral values and character formation, and of the most intimate relations between one individual and another. Penetrating further into the realm of the mind, we are faced with problems of the ethical basis of philosophy and of the ultimate ideals of life itself. Here we find vistas opening out inviting action, and leading to further inquiry, especially in the universities, for on many of the burning questions of human biology no clear decision has yet been reached.

Yet in nearly every case existing knowledge is decades ahead of educational practice, and we have before us the immense task of trying to make good the lag between general opinion and what is already known. But the function of human biology does not end at being an academic discipline, for it must be given effect in public administration and national policy, since national policies are the mass movements of mankind. How deeply involved human biology is in national policy comes out clearly in this present war. The whole policy of the Fascist powers rests on conceptions of human biology which were disproved by the leading biologists of the world some decades ago; while the conceptions themselves spring from human attributes and environmental conditions no longer holding full sway in the countries of their origin. By contrast, the Democracies, often almost unconsciously, all too tardily, are in the process of putting into action what is best in biological knowledge, as, for example, in the schemes for free milk, health protection, etc.

Yet in all this, little help is forthcoming from our universities and educational authorities. Only as it were by chance do we come across pointers which show the way, as during the Conference on Science and World Order recently held in London. The widespread apathy with regard to pressing problems of human biology affecting the nation's future is a sad reflection on the ideals for which we are at war. But the outlook for human biology now is more favourable than it has been for a very long time.

Only one or two points have been made here in the attempt to show how important human biology is to educational principles and practice. Like any other

subject it has special applications in special cases and emergencies, and it certainly has its novel and unique problems during war-time. There is scarcely any need to enumerate the special war-time problems which are worthy of consideration from the point of view of human biology. A mere mention of a few of them is sufficient to give basis for later discussion. For example, the whole problem of evacuation. This was one of the most successful sociological experiments of our time, when it first took place; that is so far as the organization of the actual evacuation itself is concerned. But there seems to have been very little consideration of biological and psychological aspects of the case in the reception areas themselves. Authorities, for example, apparently underestimated the strength of parental affection, or overestimated parental self-control. Insufficient regard was directed to the emotional unity of the family, and as little to its economic unity. That is one of the main reasons why the initial success of the scheme has since been generally negatived in a large number of cases. Another problem is that of broken homes and broken family life caused either by evacuation or the calling up of menfolk and of women into the Fighting Services or movement of women and men to other industrial areas. Emotional tension due to the War has received a certain amount of study by the Ministry of Health, chiefly from the medical point of view. Certain psychological studies have also been made, but the problem as a whole has not received the attention which it deserves. The effect of the War on young adolescents is also deserving of attention, especially in the many cases where abnormally high wages are being paid to young boys and girls. These are just a few examples of special problems raised by the War, and there are no doubt many others, all of which come within the purview of human biology.

At no point in the nation's history have young people had such independence and freedom as to-day. Never before have they had such opportunities of following the wrong lines of individual and social development, but complementary to this, never has there been such an opportunity for teachers to offer correct guidance. Never has there been such opportunity for building up the characters of the younger generation on a foundation of true knowledge of personal worth and thus preventing them from being lured away by the cheap type of personality appeal in which an individual is singled out for the special favours of fortune. Emotions come before understanding and personal success bears no relation to the common good. So much nowadays depends upon mutual sympathy and understanding particularly between the opposite sexes. All this was shown only recently by messages sent by the Prime Minister and others to the great International Youth Rally recently held in London telling youth of its responsibilities towards the nation, but we must also realize that youth in a social sense has definite claims upon those of maturer years and this is one of them. That youth deserves our help goes without saying, but how we are going to carry it out is a matter for discussion. That youth can be misguided *en masse* has been shown by Nazi Germany where the Hitler Youth, probably through no fault of their own, may now be considered to be workers of iniquity and of primitive passions. If it is possible to organize and misguide youth, then it should be equally possible to organize and guide youth along the right lines. This could be done through the school, youth organizations, etc.; but the unit of the family itself must never be ignored. It is necessary to impress upon youth the biological principles of family life and to make them realize as few do that (as Cardinal Hinsley pointed out in a recent stirring address in Westminster Cathedral) the dignity of the family is not wrapped up solely in the begetting of children.

ISLAND FAUNA RESEARCH

THE University of Oxford, since 1938, has contributed towards the cost of research into the problems of island faunas, with special reference to the Pacific, and, in particular, the Marquesas Isles.

Mr. E. P. Mumford, of Jesus College, who is conducting the inquiry, has made it one of his chief aims to obtain publication of faunistic lists by experts, so that information may be collated and available. An important recent publication from the Smithsonian Institution (Misc. Coll., 99, No. 8; 1941) by Prof. Jackson is a check-list of the terrestrial and freshwater Isopoda of Oceania. This was made possible by grants-in-aid from the contributions of the Royal Society and the British Association to the central fund at Oxford, and from the publication committee of the University of London. The paper contains a noteworthy discussion of the whole subject in which Prof. Jackson concludes: "The assumption of land connections between the islands is gratuitous and would seem to provide more time than is necessary to account for the comparatively small range of differences observed, while the assumption that man is responsible [for the distribution of the Isopods under review] would seem to provide too little."

Other lists that have been published in connexion with the activities of this research include, among Insecta, the Collembola, Dermaptera, Embioptera, Anoplura, Mallophaga, Homoptera (Cercopidæ), Neuroptera, Coleoptera (some Adephaga, Polyphaga-Diversicornia, Lamellicornia, and Rhynchophora), Hymenoptera (Cynipoidea, Formicoidea, Serphoidea, Bethylidæ and Anteonidæ), Diptera (some Nematocera, Aschiza, and Pupipara), and Siphonaptera. Among Crustacea, the Amphipoda: among Arachnida, the Chelonethida. These lists have appeared in publications of the Bernice P. Bishop and other museums, and in scientific journals.

The recently published fourth volume of the Proceedings of the Sixth Pacific Science Congress at San Francisco in 1939 contains, among other contributions to faunistic questions, two papers by Mr. Mumford on the present status of studies of faunal distribution with reference to oceanic islands, and on the present status of knowledge of Polynesian freshwater faunas. A preliminary account of an investigation of the Euploeine butterflies of Melanesia is contributed by Prof. G. D. Hale Carpenter.

Those interested in furthering this investigation by observations or records, or desirous of obtaining information, are asked to communicate with Mr. E. P. Mumford, Box 802, Stanford University, California, or with Prof. Hale Carpenter, University Museum, Oxford.

TUNG-OIL TREE CULTIVATION IN INDIA

THIS tree (*Aleurites fordii* Hemsl.), an inhabitant of China, produces the Chinese wood oil of commerce, the oil being used in the manufacture of paints and varnishes owing to its rapid drying qualities. It came into prominence during the War of 1914-18 when it was extensively used in the treatment of aeroplane fabrics as a water-resisting varnish. China is the chief source of production of tung oil, and the United States the principal consumer. In 1936 the United States imported more than 600,000 tons, and large quantities are annually imported by Great Britain and India.

In China the tree grows in profusion in the mountainous tropical and sub-tropical regions. The United States commenced to form plantations of the species early in the present century, and there are now about 175,000 acres, chiefly in Mississippi and other southern States. Experiments in its cultivation in the British Empire were first initiated by the Imperial Institute in 1917 in India and a number of Colonies, but they were inconclusive. The matter was taken up in 1927 by the Advisory Committee of the Institute in collaboration with the Director of Kew and the Director of the Research Association of British Paint, Colour and Varnish Manufacturers, seed obtained from China and Florida being distributed to various countries of the Empire.

It is said that there are now grounds for considering that, so far as India and Burma are concerned, the industry can be developed either as a self-supporting one, in view of the growing commercial importance of tung oil, or as a cottage industry in places where the plants can be easily grown and seeds marketed, or in tea-gardens as a subsidiary industry. This opinion is based on the fact that experiments have now been carried out for two decades with varying measures of success in localities in India and Burma and in Ceylon, Malaya and East and South Africa. The question is dealt with in *Indian Forest Records* (New Series) Sylviculture, "Note on the Cultivation of the Tung-oil Tree (Aleurites spp) in India", by M. V. Laurie and J. N. Sen Gupta, both of the Forest Research Institute, Dehra Dun, India, 4, No. 3 (Manager, Govt. of India Press, Delhi, 1941). Artificial regeneration, nursery practice, manures, planting sites, tending, dangers, costs and growth and yield are discussed.

A hint is given that there are market competitors in drying oils such as Perilla oil, Viticica oil and Po-yok oil, although they are inferior, while recently synthetic resins have been developed which may reduce the use of tung oil in process work, one of the latest developments being a castor oil derivative.

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Indian Forest Records (New Series). Botany, Vol. 2, No. 1: Common Grasses of the United Provinces. By Dr. N. L. Bor. Pp. vii+222+64 plates. (Delhi: Manager of Publications.) 9.14 rupees; 15*s.* 6*d.* [2411

FORTHCOMING EVENTS

SATURDAY, JANUARY 3

JOINT MEETING OF TECHNICAL INSTITUTIONS arranged at the request of the Mines Department (in the H. H. Wills Laboratory, Royal Fort, Bristol), at 2.30 p.m.—Discussion on the Best Ways and Means of Improving the Efficient Use of Fuel and Power in Existing Industrial Plants, under Present Conditions, and to Invite Constructive Suggestions. (To be opened by Mr. J. G. Bennett.)

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